Technologies for Prehistoric & Historic Preservation

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D. C. 20510

J952-98

Office of Technology Assessment

Congressional Board of the 99th Congress

TED STEVENS, *Alaska, Chairman*

MORRIS K. UDALL, *Arizona, Vice Chairman*

Senate

ORRIN G. HATCH
Utah

CHARLES McC. MATHIAS, JR.
Maryland

EDWARD M. KENNEDY
Massachusetts

ERNEST F. HOLLINGS
South Carolina

CLAIBORNE PELL
Rhode Island

House

GEORGE E. BROWN, JR.
California

JOHN D. DINGELL
Michigan

CLARENCE E. MILLER
Ohio

COOPER EVANS
Iowa

DON SUNDQUIST
Tennessee

JOHN H. GIBBONS
(Nonvoting)

Advisory Council

WILLIAM J. PERRY, *Chairman*
H&Q Technology Partners

DAVID S. POTTER, *Vice Chairman*
General Motors Corp. (Ret.)

EARL BEISTLINE
Consultant

CHARLES A. BOWSHER
General Accounting Office

CLAIRE T. DEDRICK
California Land Commission

S. DAVID FREEMAN
Lower Colorado River Authority

MICHEL T. HALBOUTY
Michel T. Halbouty Energy Co.

CARL N. HODGES
University of Arizona

RACHEL McCULLOCH
University of Wisconsin

CHASE N. PETERSON
University of Utah

JOSEPH E. ROSS
Congressional Research Service

LEWIS THOMAS
*Memorial Sloan-Kettering
Cancer Center*

Director

JOHN H. GIBBONS

The Technology Assessment Board approves the release of this report. The views expressed in this report are not necessarily those of the Board, OTA Advisory Council, or individual members thereof.

Recommended Citation:

U.S. Congress, Office of Technology Assessment, *Technologies for Prehistoric and Historic Preservation*, OTA-E-319 (Washington, DC: U.S. Government Printing Office, September 1986).

Library of Congress Catalog Card Number 86-600574

For sale by the Superintendent of Documents
U.S. Government Printing Office, Washington, DC 20402

Foreword

Archaeological remains and historic structures and landscapes are important tangible reminders of this Nation's rich and diverse cultural heritage. They provide a sense of our past and contribute in other ways to our quality of life. Yet, in recent years, as the result primarily of population shifts, urban growth, and energy development, the stresses on these unique, nonrenewable cultural resources have increased dramatically. As this assessment makes clear, the appropriate use of a wide variety of preservation technologies, many of which were originally developed for applications in natural science and engineering, could reduce many of these stresses.

This report presents the primary findings of an assessment requested by the House Committee on Interior and Insular Affairs. The Subcommittee on Public Lands is carrying out a major review of how Federal agencies implement Federal preservation policy. This assessment directly supports the Committee's review by showing how the uses of certain methods, techniques, as well as tools and equipment can assist Federal, State, and local preservation efforts.

The assessment takes the unusual step of focusing on the applications of preservation technologies rather than preservation disciplines. It examines the current use of preservation technologies and identifies research and development needs. It also explores how improvements in Federal policy and implementation can facilitate the more effective use of technologies appropriate for managing this country's prehistoric and historic cultural resources.

In undertaking this assessment, OTA sought the contributions of a wide spectrum of knowledgeable and interested individuals. Some provided information and guidance, others reviewed drafts of the report. OTA gratefully acknowledges their contributions of time and intellectual effort. OTA also appreciates the timely help rendered by a number of individuals from the National Park Service.

John H. Gibbons

JOHN H. GIBBONS
Director

Review Panel

Robert Baboian
Corrosion Laboratory
Texas Instruments
Attleboro, MA

Carole L. Crumley
Department of Anthropology
University of North Carolina
Chapel Hill, NC

Hiroshi Daifuku
Historic Preservation Consultant
Washington, DC

James Ebert
Ebert & Associates
Albuquerque, NM

Joel Grossman
Grossman & Associates, Inc.
New York, NY

Robert Harvey
Department of Landscape Architecture
Iowa State University
Ames, IA

Ruthann Knudson
Woodward-Clyde Consultants
Walnut Creek, CA

Charles Mazel
Klein Associates
Salem, NH

John H. Myers
College of Architecture
Georgia Institute of Technology
Atlanta, GA

Patricia O'Donnell
Walmsley & Co.
New York, NY

Mimi Rodden
Carson City, NV

Reynold Ruppe
Department of Anthropology
Arizona State University
Tempe, AZ

Susan E. Schur
Technology and Conservation
Boston, MA

Thomas Spiers
Benatec Associates
Harrisburg, PA

M. Jane Young
Department of Anthropology
University of Texas
Austin, TX

NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the review panel and workshop participants. The panel and workshops do not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

OTA Project Staff on Prehistoric and Historic Preservation

Lionel S. Johns, *Assistant Director, OTA*
Energy, Materials, and International Security Division

Peter D. Blair, *Energy and Materials Program Manager*

Richard E. Rowberg, *Energy and Materials Program Manager until December 1985*

Ray Williamson, *Project Director*

Mary Lee Jefferson, *Analyst*

Jannelle Warren-Findley, *Contractor*

Administrative Staff

Lillian Chapman Linda Long

Workshop Participants

Technologies for the Preservation of Archaeological Sites and Structures, Dec. 3-4, 1985

Dena Dincauze, *Chair*
Department of Anthropology, University of Massachusetts, Amherst, MA

Annetta Cheek
Archeology Assistance Division
Office of Surface Mining
Washington, DC

James Ebert
Ebert & Associates
Albuquerque, NM

Jeffrey Eighmy
Department of Anthropology
Colorado State Univesity
Fort Collins, CO

James Judge
Fort Burgwin Research Center
Southern Methodist University
Dallas, TX

Timothy Kohler
Department of Anthropology
Washington State University
Pullman, WA

Mark Leone
Department of Anthropology
University of Maryland
College Park, MD

Charles Pearson
Coastal Environments, Inc.
Baton Rouge, LA

G.R. Rapp, Jr.
College of Science and Engineering
University of Minnesota
Duluth, MN

Joseph Schuldenrein
Commonwealth Associates
Jackson, MI

Thomas Sever
National Aeronautics and Space Administration
National Space Technology Laboratories
Bay St. Louis, MS

R.E. Taylor
Department of Anthropology
University of California
Riverside, CA

Leslie Wildesen
Colorado Heritage Center
State Historic Preservation Office
Denver, CO

Technologies for the Preservation of Historic Structures, Jan. 28-29, 1986

James Marston Fitch, *Chair*
Department of Historic Preservation, Beyer Blinder Belle Architects & Planners, New York, NY

Terry Amburgey
Forest Products Laboratory
Mississippi State University
Mississippi State, MS

Jan C.K. Anderson
RESTORE
New York, NY

Robert Baboian
Corrosion Laboratory
Texas Instruments
Attleboro, MA

Hiroshi Daifuku
Historic Preservation Consultant
Washington, DC

Tomas H. Spiers
Benatec Associates
Harrisburg, PA

Geoffrey Frohnsdorff
Center for Building Technology
National Bureau of Standards
Gaithersburg, MD

Larry Jones
Old House Journal
Brooklyn, NY

Robert Kapsch
National Park Service
Washington, DC

Judith Kitchen
Ohio State Historic Preservation Office
Columbus, OH

John H. Myers
Center for Architectural Conservation
College of Architecture
Georgia Institute of Technology
Atlanta, GA

Susan E. Schur
Technology and Conservation
Boston, MA

Norman Weiss
Center for Preservation Research
Columbia University
New York, NY

Technologies for Underwater Archaeology and Maritime Preservation, Feb. 20, 1986

Reynold Ruppe, *Chair*
Department of Anthropology, Arizona State University, Tempe, AZ

J. Barto Arnold
Texas Antiquities Committee
Austin, TX

Frank Busby
Busby Associates, Inc.
Arlington, VA

Calvin R. Cummings
National Park Service
Denver, CO

Anne G. Giesecke
Underwater Archaeologist
Arlington, VA

Daniel Lenihan
Submerged Cultural Resources Unit
National Park Service
Santa Fe, NM

Charles Mazel
Klein Associates
Salem, NH

Craig Mullen
Eastport International
Upper Marlboro, MD

Carol Olsen
Department of Maritime Preservation
National Trust for Historic Preservation
Washington, DC

J.K. Orzech
Scripps Institute of Oceanography
La Jolla, CA

Sheli O. Smith
Mariners Museum
Mariners Drive
Newport News, VA

Technologies for the Preservation of Planned Landscapes and Other Outdoor Sites, Feb. 27-28, 1986

Patricia O'Donnell, *Chair*
Walmsley & Co., Inc., New York, NY

Shary P. Berg
Frederick Law Olmsted National
Historic Site
Brookline, MA

Carole L. Crumley
Department of Anthropology
University of North Carolina
Chapel Hill, NC

Nomi Greber
Cleveland Museum of Natural History
Cleveland, OH

Robert Harvey
College of Design
Iowa State University
Ames, IA

Catherine Howett
Bunting Institute
Radcliffe College
Cambridge, MA

Thomas J. Kane
Kane, Liede, and Ratyna, P.C.
Pleasantville, NY

Timothy Keller
Land and Community Associates
Charlottesville, VA

Setha M. Low
Department of Landscape Architecture
and Regional Planning
University of Pennsylvania
Philadelphia, PA

Martin McGann
Institute of Historic Horticulture
Sleepy Hollow Restorations
Tarrytown, NY

Hugh C. Miller
Historic Architecture Division
National Park Service
Washington, DC

Darwina L. Neal
National Park Service
National Capital Region
Washington, DC

Ford Peatross
Prints and Photographs Division
Library of Congress
Washington, DC

Scott Weinberg
School of Environmental Design
University of Georgia
Athens, GA

M. Jane Young
Department of Anthropology
University of Texas
Austin, TX

Technologies for the Physical Protection of Prehistoric and Historic Sites, Apr. 14-15, 1986

Mimi Rodden, *Chair*
Carson City, NV

David G. Battle
National Park Service
Denver, CO

Richard Bierce
National Trust for Historic Preservation
Washington, DC

Fred Blackburn
White Mesa Institute
College of Eastern Utah
Blanding, UT

Joel Grossman
Grossman & Associates, Inc.
New York, NY

Richard Haines
Bureau of Land Management
Division of Lands and Renewable Resources
Portland, OR

James Hester
Waterways Experiment Station
U.S. Army Corps of Engineers
Vicksburg, MS

Captain Alvin Hinton
U.S. Park Police
Washington, DC

Tom King
Office of Cultural Resource Preservation
Advisory Council on Historic Presrvation
Washington, DC

Ruthann Knudson
Woodward-Clyde Consultants
Walnut Creek, CA

Felix Lavicka
Analytics, Inc.
Tinton Falls, NJ

J. Rodney Little
State Historic Preservation Office
Annapolis, MD

Constance Ramirez
Department of the Army
Washington, DC

Tupper Thomas
Prospect Park
Brooklyn, NY

Acknowledgments

The following individuals contributed to this study in a variety of ways. OTA is grateful for their assistance:

Mary Lee Allen
Gunston Hall

Bruce Anderson
National Park Service

Christy Arrington
Bureau of Land Management

Rick Athern
Bureau of Land Management

Carl Barna
Bureau of Land Management

John Belshe
U.S. Army Corps of Engineers

Walter Bender
Massachusetts Institute of Technology

Jim Bradford
National Park Service

John Burns
National Park Service

John Byrne
National Park Service

Tony Carrell
National Park Service

Elliott Carroll
Office of the Architect of the Capitol

Beth Cole
International Masonry Institute

John Cullinane
Advisory Council on Historic Preservation

Karl Ludwig Dasser
Bayerishes Landesamt für Denkmalpflege, Munich

Robert B. DeBlieux
Louisiana Office of Cultural Development

Evan de Blois
U.S. Forest Service

Tom De Haven
National Park Service

Diane Dimkoff
National Archives and Records Administration

Paul Dolinsky
National Park Service

James R. Druzik
The Getty Conservation Institute

Robert Dunnell
Washington State University

Mark R. Edwards
Maryland Historical Trust

Mary Farrell
National Park Service

Laura Feller
National Park Service

Helen C. Fenske
New Jersey Department of Environmental Protection

Cynthia Field
Smithsonian Institution

Charles Fisher
National Park Service

Carl Fleischauer
American Folklife Center
Library of Congress

George Frison
University of Wyoming

Diana Gelburd
Soil Conservation Service

Leland Gilsen
Oregon State Historic Preservation Office

Nancy W. Hawkins
Louisiana Division of Archaeology

Helen Hooper
Society for Historical Archaeology
Advisory Council on Underwater Archaeology

Stanley M. Hordes
Consulting Historian
Santa Fe, NM

Barbara J. Howe
Department of History, West Virginia University

Mary Hufford
American Folklife Center
Library of Congress

Winston Hurst
Edge of the Cedars Museum

Heather Huyck
National Park Service

Ken Ireland
National Park Service

Mary Ison
Library of Congress

Jake Ivy
National Park Service

Alan Jabbour
American Folklife Center
Library of Congress

Squire Jaros
Michigan Historic Preservation Section

Neal C. Johannsen
Alaska Department of Natural Resources

James Jordan
National Trust for Historic Preservation

Debra Katz
National Park Service

Bennie C. Keel
National Park Service

John J. Knoerl
National Park Service

Bruce Kriviskey
American Institute of Architects

Kathryn M. Kuranda
Nevada Division of Historic Preservation and Archeology

William Lebovitch
National Park Service

Suzanne Lewis
National Park Service

Richard Livingston
Environmental Protection Agency

Nellie Longsworth
Preservation Action

Shiela MacFarlin
Bureau of Land Management

Ed Malony
Bureau of Land Management

Thomas E. Marceau
Wyoming State Archives, Museums, & Historical Department

Daniel Martin
Bureau of Land Management

Jim Maxon
Bureau of Reclamation

Judith McCulloh
University of Illinois Press

Edward Miller
National Oceanic and Atmospheric Administration

Nancy Miller
National Conference of State Historic Preservation Officers

Page Putnam Miller
National Coordinating Committee for the Promotion of History

James Mueller
National Park Service

Lee H. Nelson
National Park Service

Marilyn W. Nickels
National Park Service

Michele Pacifico
National Archives and Records Administration

Richard Pankratz
Kansas State Historical Society

Paul Pearson
Historic Inns of Annapolis, Maryland

George W. Percy
Florida Division of Archives, History and Records Management

Charles Peterson
Architect

John Peterson
National Park Service

Kenneth Peterson
Bureau of Land Management

Dwight Pitcaithley
National Park Service

Allan Postlethwaite
Smithsonian Institution

Paul Putz
South Dakota Historical Society Board of Trustees

John W. Renaud
National Park Service

Jerry Rogers
National Park Service

Todd Rutenbeck
Bureau of Reclamation

Michael Scardaville
Department of History
University of South Carolina

Curtis Schaafsma
New Mexico State Historic Preservation Office

Polly Schaafsma
Santa Fe, NM

Günter Schelling
Bayerische Verwaltung der Saatlichen
Schlösser, Garten und Seen, Munich

Peter Schmidt
Museo Regional Instituto
Nacional Antropologia & Historia, Yucatan

Dorna J. Schober
Arizona State Parks

Payson Sheets
University of Colorado

Susan Sherwood
National Park Service

Steve Sigstad
National Forest Service

Brona Simon
Massachusetts Historical Commission

Rolf Snethlage
Bayerishes Landesamt für Denkmalpflege, Munich

Jacob E. Thomas
Washington State Office of Archaeology and Historic Preservation

Jim Trott
National Park Service

Nicolas Veloz
National Park Service

Ken Verana
National Park Service

Walter Wait
National Park Service

Alicia Weber
National Park Service

Douglas Reid Weimer
Congressional Research Service
Library of Congress

Thomas E. (Ted) Weir, Jr.
National Archives and Records Administration

Bill Westermeyer
Office of Technology Assessment

Margaret F. Will
Historic Preservation Consultant

St. Clair Wright
Historic Annapolis, Inc.

Barbara Wyatt
State Historical Society of Wisconsin

Contents

Page

Chapter 1: Summary 3

Chapter 2: Background 30

Chapter 3: Research 43

Chapter 4: Restoration, Conservation, Maintenance, and Protection 83

Chapter 5: Preservation Information 107

Chapter 6: Public Information 121

Chapter 7: Technology and Preservation Policy 133

Appendix A: Cultural Resources Management Laws and Regulations 161

Appendix B: Documentation and Conservation of Rock Art 165

Appendix C: Registration and Private Ownership of Archaeological Objects . . . 169

Appendix D: National Register Criteria From the Introduction to: "How To Apply the National Register Criteria for Evaluation" 174

Appendix E: National Register of Historic Places Inventory—Nomination Form 176

Appendix F: U.S. National Park Service Cultural Programs 178

Appendix G: Advisory Council on Historic Preservation 184

Appendix H: National Trust for Historic Preservation 187

Appendix I: National Building Museum 186

Index 189

Report Brief

The United States is losing important parts of its cultural heritage at an alarming rate. Preserving America's prehistoric and historic sites contributes to our quality of life, and that of future generations, by increasing our understanding of U.S. history. It also provides economic benefits such as jobs and increased tourism.

To carry out their legal responsibilities for preserving these important historical resources, Federal agencies must have cost-effective methods for studying and protecting them. Modern technologies may provide cost-effective methods to help stem the loss of these irreplaceable resources, especially if technologies developed in other fields can be transferred to preservation. The lack of adequate technology transfer demonstrates a conspicuous need for an institution to coordinate research, disseminate information, and provide training about new technologies. Congress could establish:

- **a Federal Center for Preservation Technology** within the Department of the Interior or some other agency;
- **a National Center for Preservation Technology** managed by a consortium of universities; or
- **a Preservation Technology Board** composed of professionals from all parts of the preservation community, to provide guidance for a Center.

The stewardship of prehistoric and historic cultural resources has not received sufficient attention within the Department of the Interior and other Federal agencies. Congress could consider altering the institutional structure of Federal preservation efforts by:

- establishing a separate agency to manage all Federal cultural programs;
- creating an independent agency devoted to the care and protection of prehistoric and historic cultural resources;
- reorganizing the Department of the Interior to provide for an Assistant Secretary for Natural and Cultural Resources; or
- leaving the current Federal preservation structure intact.

Even if the structure were left intact, Federal agencies could still improve their efforts by developing sustained, organized maintenance programs for historic Federal properties; improving coordination and information sharing among agencies; and focusing on using new, efficient technologies.

Some foreign countries have been using advanced technologies for preservation longer than the United States. In some cases their technologies represent significant advances over U.S. practices. Foreign experiences with preservation techniques, methods, and equipment should be examined closely for possible transfer to U.S. applications.

Preserving Historic Structures.—Tax incentives now available for rehabilitating qualified historic buildings demonstrate the success of the public-private sector partnership in historic preservation. Their continued availability would assist the retention of many more of America's historic structures.

Landscapes Preservation.—Significant prehistoric and historic landscapes continue to be lost because they are not recognized as important to U.S. history. Passage and implementation of the Olmsted Heritage Landscapes Act of 1985 (H.R. 37) could aid the collection of information on all U.S. historic designed landscapes. It could also enhance public awareness of other significant prehistoric and historic landscapes.

Shipwrecks Preservation.—Historic shipwrecks in coastal waters, receive very little protection from current Admiralty Laws. Yet they contain a wealth of important information concerning the exploration and settlement of this country. Passage and implementation of the proposed Abandoned Shipwrecks Act (H.R. 3558/S. 2569) would make it possible to preserve significant historic shipwrecks for future generations by ceding their jurisdiction, ownership, and oversight to the States.

Stemming Looting and Vandalism.—Both are serious threats to prehistoric and historic cultural resources. Advanced monitoring devices may aid the law enforcement process, but the United States also needs to improve enforcement of policies dealing with illicit excavation and trafficking in stolen artifacts. Congress could consider amending the Archaeological Resources Protection Act of 1979 and other statutes to permit private registration of antiquities obtained in supervised archaeological excavations on private land.

Chapter 1
Summary

Contents

Page
Introduction 5

Context 7

Major Findings 8

Federal Preservation Policy 10
  Applying Technologies in Prehistoric and Historic Preservation 11
  Federal Management of Historic Cultural Resources 13
  Survey of Prehistoric and Historic Landscapes 14
  Historic Shipwrecks and Other Submerged Cultural Resources 14
  Protection of Prehistoric and Historic Cultural Resources 15

The Preservation Process 16
  Discovery 16
  Recording and Measurement 20
  Analysis and Evaluation 21
  Restoration, Conservation, and Maintenance 21
  Protection From Catastrophic Losses 23
  Preservation Information 23
  Public Education 25

Table

Table No. *Page*
1. Prehistoric and Historic Preservation Laws and Executive Orders 6

Chapter 1
Summary

INTRODUCTION

The preservation of this country's prehistoric and historic heritage has a long tradition of community support and academic and political interest. Federal preservation legislation, commencing in 1906,[1] reflects the national value and significance that U.S. prehistoric and historic cultural resources possess, whether managed by Federal, State, or local governments or private citizens. As the *National Historic Preservation Act* asserts,

> . . . the preservation of this irreplaceable heritage is in the public interest so that its vital legacy of cultural, educational, aesthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans.[2]

Virtually every congressional district contains federally managed sites, structures, or landscapes of prehistoric and historic interest.[3] The ability of Federal agencies to carry out their preservation responsibilities, within the context of managing public lands[4] and other duties, rests increasingly on discovering and using cost-effective techniques, methods, and equipment for studying and protecting these important cultural resources.

This assessment was requested by the House Committee on Interior and Insular Affairs to assist the committee's legislative authorization and oversight of Federal preservation efforts. During 1986, the 20th anniversary of passage of the *National Historic Preservation Act*, the Subcommittee on Public Lands initiated a major review of how Federal agencies implement the provisions of laws relating to prehistoric and historic properties (table 1). The findings of this assessment support the subcommittee's efforts to review how the use of technologies, including methods and techniques, as well as tools and equipment, can assist historic preservation.

As the population of this country has grown and urban centers have become more dense and expanded into the countryside, the stresses on cultural resources have increased dramatically. The destruction of shipwrecks and submerged archaeological sites, particularly along the coasts of Texas and Florida, has also increased significantly in recent years. Currently, the United States is losing its prehistoric and historic cultural resources at an alarming rate[5] in spite of the best efforts of preservation professionals to identify and protect them. Because the national inventory of these cultural resources is far from complete, sites, structures, and landscapes that may have prehistoric or historic significance may not be cataloged and protected before they have been destroyed or dramatically altered.

This assessment provides an overview of technologies relating to the care and preservation of cultural resources. In this assessment, **preservation technology refers broadly to any equipment, methods, and techniques that can be applied to the discovery; analysis; interpretation; restoration; conservation; protection; and management of prehistoric and historic sites, structures, and landscapes.** The assessment also examines a variety of options related to the use of preservation technologies and suggests improve-

---

[1] *The Antiquities Act of 1906* (Public Law 59-209).

[2] National Historic Preservation Act (Public Law 89-665), Sec. 1(b) (Purpose of the Act), para. 4.

[3] See, for example, the National Register of Historic Places, which lists significant prehistoric and historic places throughout the United States.

[4] For example, the Federal Land Policy and Management Act of 1976, Sec. 102(a)(8), calls for "the public lands [to] be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use."

[5] For example, experts estimate that fewer than 10 percent of the prehistoric Mimbres sites in southwestern New Mexico are free from damage due to looting and vandalism. See Carol Ann Bassett, "The Culture Thieves," *Science*, July/August 1986, p. 22. In addition, see the extensive discussion in Leslie E. Wildesen, "The Study of Impacts on Archaeological Sites," *Advances In Archaeological Method and Theory* 5, 1982, pp. 51-96.

Table 1.—Prehistoric and Historic Preservation Laws and Executive Orders

Laws:
- The Antiquities Act of 1906, Public Law 59-209 (6 U.S.C. 431-433)
- The National Park Service Organic Act (An Act of Aug. 25, 1916), (39 Stat. 535, 16 U.S.C. 1)
- The Historic Sites Act of 1935, Public Law 74-292 (16 U.S.C. 461-467)
- The National Historic Preservation Trust Act of 1949, Public Law 81-408 (63 Stat. 927, 16 U.S.C. 468 et seq.)
- The Submerged Lands Act of 1953, Public Law 83-31 (67 Stat 29, 43 U.S.C. 1301 et seq.)
- Outer Continental Shelf Lands Act, Public Law 83-212 (67 Stat. 462, 43 U.S.C. 1331 et seq.)
- The Management of Museum Properties Act of 1955, Public Law 84-69 (16 U.S.C. 18f)
- The Reservoir Salvage Act of 1960, Public Law 86-523 (16 U.S.C. 469-469c)
- The Department of Transportation Act of 1966, Public Law 89-670 (80 Stat. 931)
- The National Historic Preservation Act of 1966, Public Law 89-665 (16 U.S.C. 470)
- The National Environmental Policy Act of 1969, Public Law 90-190 (16 U.S.C. 470)
- Executive Order 11593, "Protection and Enhancement of the Cultural Environment," May 13, 1971. (36 F.R. 8921)
- Alaska Native Claims Settlement Act, Public Law 92-203 (85 Stat. 688, 43 U.S.C. 1601-1624)
- The Archaeological and Historical Preservation Act of 1974, Public Law 93-291 (88 Stat. 174, 16 U.S.C. 469 et seq.)
- American Folklife Preservation Act of 1976, Public Law 94-201 (20 U.S.C. 2101-2107)
- The American Indian Religious Freedom Act of 1978, Public Law 95-341 (92 Stat. 46a, 42 U.S.C. 1996)
- Central Idaho Wilderness Act of 1980, Public Law 96-312 (94 Stat. 948, 16 U.S.C. 1274)
- National Historic Preservation Act Amendments of 1980, Public Law 96-515 (94 Stat. 2987, 16 U.S.C. 470 et seq.)
- The Archaeological Resources Protection Act of 1979, Public Law 96-95 (16 U.S.C. 470aa et seq.)
- Convention on Cultural Property Implementation Act, Public Law 97-446 (96 Stat. 2350-2363, 19 U.S.C. 2601-2613)

Legislation under consideration in the 99th Congress:
- R.M.S. TITANIC Memorial Act of 1985 (H.R. 3272)
- The Abandoned Shipwreck Act of 1985 (H.R. 3558 and S. 2569)
- The Olmsted Heritage Landscapes Act of 1985 (H.R. 37)

Regulations:[a]
- 43 CFR 3 (Antiquities Act)
- 43 CFR 7 (Archeological Resources Protection Act of 1979)
- 36 CFR 60 (National Historic Preservation Act of 1966 (NHPA) and EO 11593)
- 36 CFR 61 (NHPA and EO 11593)
- 36 CFR 63 (NHPA and EO 11593)
- 36 CFR 65 (Historic Sites Act of 1935)
- 36 CFR 66 (Archaeolgical and Historic Preservation Act of 1974)
- 36 CFR 68 (NHPA)
- 36 CFR 800 (NHPA and EO 11593)
- 40 CFR 1500 (NEPA) "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act."

Standards and Guidelines for Historic Preservation:

"The Secretary of the Interior's **Standards for Rehabilitation** and Guidelines for Rehabilitating Historic Buildings," National Park Service (revised 1983), booklet.

"The Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation," *Federal Register* 48, No. 190, Thursday, Sept. 29, 1983.

"Final Uniform Regulations, Archaeological Resources Protection Act of 1979," *Federal Register* 49, No. 4, Friday, Jan. 6, 1984.

"Draft Guidelines for Historic and Archeological Resource Management: Federal Agency Responsibilities Under Section 110 of the National Historic Preservation Act," National Park Service, Feb. 5, 1986.

Advisory Council on Historic Preservation, Executive Director's "Procedures for Review of Proposals for Treatment of Archaeological Properties: Supplementary Guidance," 45 *Federal Register* 78808.

Advisory Council on Historic Preservation "Protection of Historic Properties," 36 CFR Part 800, *Federal Register* 51, No. 169, Sept. 2, 1986.

[a] Regulations are promulgated, adopted, and then compiled in the Code of Federal Regulations (CFR), in order to implement provisions of general laws. The name of the act it implements follows each citation.

SOURCE: U.S. Department of the Interior and OTA.

ments in implementing current policy. It does not address the preservation of paintings, books, and other artifacts; however, some technologies used for their preservation are also applicable to sites, structures, and landscapes.

In the course of this assessment, OTA held a series of five workshops that explored the range of issues raised by the application of technologies to prehistoric and historic preservation:

1. Technologies for the Preservation of Archaeological Sites and Structures,
2. Technologies for the Preservation of Historic Structures,
3. Technologies for Underwater Archaeology and Maritime Preservation,
4. Technologies for the Preservation of Planned Landscapes and Other Outdoor Sites, and
5. Technologies for the Physical Protection of Prehistoric and Historic Sites.

More than 100 individuals participated in the workshops, either as invited participants or as observers.

CONTEXT

The U.S. historic preservation movement has always enjoyed broad public support. It began even before Federal preservation legislation with grassroots efforts to restore and conserve the houses, monuments, and battlefields related to the history of the United States, focusing on the protection of sites and structures connected with the "great men" of U.S. history. Over time, that focus has broadened to include an exploration of the tangible and intangible remains of a more culturally heterogeneous past that includes such diverse resources as Native American sites and structures, historic vernacular buildings and landscapes, and submerged sites and shipwrecks.

This change in emphasis necessitates interdisciplinary approaches to the management and preservation of sites, structures, and landscapes. **Different stages of the preservation process may now require the involvement of specialists from such divergent fields as anthropology, archaeology, architecture, chemistry, folklore, geology, history, landscape architecture, oceanography, and planning and engineering.**

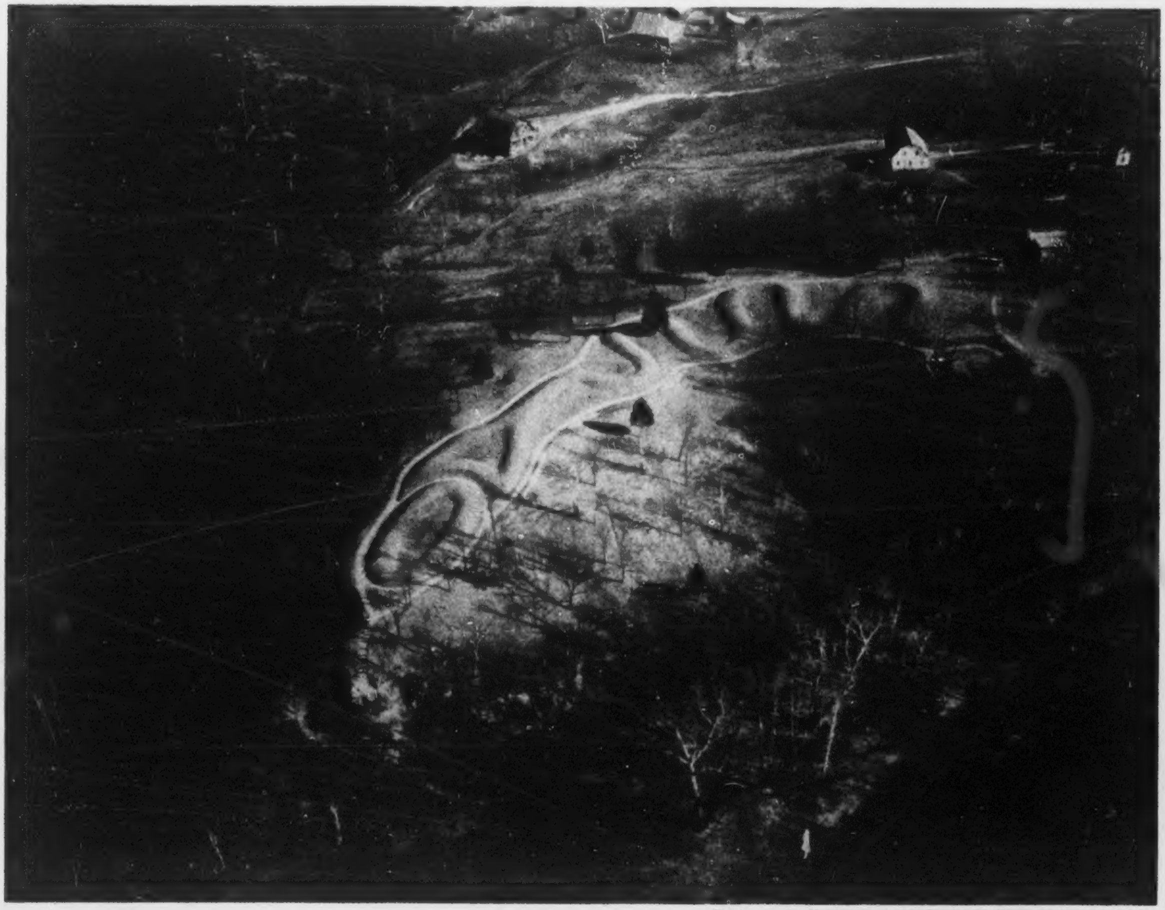


Photo credit: (Aerial photo by Dache M. Reeves, Jan. 20, 1934. Courtesy of Smithsonian Institution National Anthropological Archives).

Serpent Mound in modern farm landscape, south-central Ohio. Designed and built by the so-called Adena culture, which flourished in the first millenium B.C., this is an unusual example of thousands of earthworks found throughout the Central and Southeastern United States.

MAJOR FINDINGS

The boundaries separating the practice of archaeology and the preservation of historic structures and historic landscapes are becoming increasingly indistinct. Preservation professionals apply many of the same technologies to the study and conservation of sites, structures, and landscapes. In addition, **preservationists in all the associated disciplines share problems of obtaining access to information about technologies, training, and coordinating research.** Finally, they share the constraints of inconsistent funding and a serious lack of coordinated implementation of Federal policy.

New technologies can extend the scope of our understanding and care of the U.S. cultural her-

FERRYBANK RESTAURANT
TAVERN UNDER THE BRIDGE
ONE WAY

Photo credit: HABS/HARE, National Park Service

Brooklyn Bridge seen from Front Steet.

itage by improving the quality, quantity, type, and usefulness of data gathered. Certain technologies can also improve the authenticity of restoration, and the effectiveness of conservation and maintenance. Yet, **a variety of educational, institutional, managerial, and cost barriers inhibit the broad application of new methods, techniques, and equipment to preservation.**

In many cases, the technologies appropriate to prehistoric and historic preservation have been developed for use in natural science and engineering disciplines, but have not been adequately adapted to preservation requirements. The efficient transfer of technology developed in other disciplines to preservation is impeded by preservation specialists' frequent lack of familiarity with natural science and engineering. It is also slowed by a general lack of formalized interdisciplinary approaches to preservation problems. Similarly, many natural scientists and engineers are unfamiliar with the needs and goals of preservation, yet would be receptive to assisting the preservation community in applying new technologies.

If advanced technologies are to assume a greater role in preservation, it is important to find more effective means of transferring technology developed in other fields to prehistoric and historic preservation. These will include:

- training in the use of technologies,
- studying ways to apply known technologies to preservation problems,
- improving information-sharing and coordination,
- finding the appropriate fit of technologies to preservation problems,
- reducing costs of new technologies, and
- developing standards for the application of new technologies.

Improved transfer of technology will also require greater acceptance among preservation specialists of the role technologies play in solving cultural resource problems. It will also require more effective training in the management of cultural resources.

Other countries, particularly in Europe, have been applying technologies to preservation longer than the United States. In part this stems from their longer histories as nations. In part, it is the result of stronger and better coordinated national support for preservation from their Ministries of Culture.

In some cases foreign technologies may represent significant advances over U.S. practices. For example, German methods for recording historic structures are far more complete and result in more detailed drawings and data than U.S. methods. Archaeologists in the United Kingdom employ advanced methods of physics and chemistry in analyzing artifacts more readily than many U.S. archaeologists. European art historians also use more advanced techniques to preserve their prehistoric rock paintings and carvings. European techniques of preserving submerged wooden ships and other maritime artifacts have led U.S. efforts. The French have developed a sophisticated airborne infrared scanner for investigating landscapes, as well as advanced methods for using it effectively. **Foreign experiences with preservation techniques, methods, and equipment should be examined closely for possible transfer to U.S. applications.** The United States would also benefit by increased cooperation with other nations in developing and testing new preservation methods. It could strengthen channels of communication between the United States and other countries by reinforcing its participation in the International Council on Monuments and Sites (ICOMOS).

The preservation of the U.S. cultural heritage often results in economic benefits (such as jobs and increased tourism) to individuals and communities. In order to convince decisionmakers of the value of retaining the best or most significant historic structures and landscapes, preservationists must better quantify and measure the economic benefits of restoring and rehabilitating them. They must also articulate more effectively the benefits related to quality of life. For example, rehabilitating a historic structure may be cheaper than replacing it with a modern one. In addition, the intangible benefit of retaining a sense of belonging and place by retaining the historic integrity of a neighborhood may outweigh the purely economic benefits.

Prehistoric and historic preservation can contribute to our quality of life by increasing our

appreciation and understanding of our Nation's cultural and political history. Public education and interpretation play vital roles in preservation by enhancing the public's appreciation of our cultural heritage and involving the public in the preservation process. Yet competing mission demands within Federal agencies often cause them to neglect public education and interpretation. Hundreds of non-Federal historic organizations, such as Colonial Williamsburg, Virginia; Plimoth Plantation, Massachusetts; Cahokia Mounds State Historic Site, Illinois; and Santa Barbara Mission, California, have made significant contributions to the interpretation of prehistoric and historic cultural resources by instituting a variety of innovative volunteer and public-participation programs.

Because only a limited number of our cultural resources will be preserved with a high degree of authenticity, we must be able to understand the historical context in which prehistoric and historic activities took place. It is important to recognize the national, regional, or local significance of those sites, structures, and landscapes we wish to preserve. **Documentary research conducted at the outset of a project helps define the approach and focus of the preservation efforts. Historic materials are diverse and may include drawings, letters, maps, photographs, printed records, oral histories, and articles**. Even the existing data archives from any government agency are so numerous that current analytical techniques are often inadequate to search and evaluate them satisfactorily. **The vast amount of information available suggests preservation professionals need to gain intellectual and technological control over the knowledge base.** New information databases, automated finding aids, and related techniques are needed. A database of technical information would be particularly important.

Underwater archaeology and maritime preservation have made significant contributions to the understanding of our past, in many cases, as the direct result of the application of sophisticated technologies. If these gains are to continue, the information acquired in such studies must be integrated into the larger body of prehistoric and historic preservation information.

FEDERAL PRESERVATION POLICY

The Federal Government, "in cooperation with other nations and in partnership with States, local governments, Indian tribes, and private organizations and individuals," is responsible for providing leadership in preserving the Nation's prehistoric and historic cultural resources.[6] The National Historic Preservation Act charges the Secretary of the Interior and the independent Advisory Council on Historic Preservation with administering and guiding Federal preservation efforts. The National Park Service (NPS) acts as the lead agency in technical preservation matters for the Federal Government, and for State and local efforts. NPS, through a variety of "external programs," oversees the National Register of Historic Places, assists in historic survey and planning, and extends technical assistance to the preservation community, including other Federal agencies, States, and local governments. It administers, with the Internal Revenue Service, the tax incentives program to encourage private sector investment in rehabilitating certified income-producing historic structures. NPS also reviews State historic preservation programs and administers the matching grants-in-aid to the States for historic preservation projects. NPS protects and manages the cultural resources within the National Park system.

Every Federal agency has certain responsibilities for the prehistoric and historic properties under its control,[7] and must designate a qualified historic preservation officer.[8] The historic preservation officer plans for and coordinates the agency's preservation activities within the agency and with NPS.

---

[6] National Historic Preservation Act, Sec. 2(2).

[7] "The heads of all Federal agencies shall assume responsibility for the preservation of historic properties which are owned or controlled by such agency." National Historic Preservation Act, Sec. 110(a)(1).

[8] National Historic Preservation Act, Sec. 110(c).

The National Historic Preservation Act also established an independent Advisory Council, whose membership is composed of individuals from the private sector appointed by the President, to "advise the President and the Congress on matters relating to historic preservation, [and to] recommend measures to coordinate activities of Federal, State, and local agencies and private institutions relating to historic preservation."[9] It also review[s] the policies and programs of Federal Agencies"[10] and writes and distributes general information on historic preservation. When a Federal undertaking would affect a historic property, the Advisory Council must be afforded "a reasonable opportunity to comment" on it.[11]

Additionally, the National Historic Preservation Act authorized and directed the establishment of a National Museum of the Building Arts. Among other things, the museum "shall collect and disseminate information concerning the building arts . . . and research relating to the building arts,"[12] which include information concerning building technologies and skills.

Each State has established a State Historic Preservation Office (SHPO), mandated by the National Historic Preservation Act. The SHPOs and the Certified Local Governments (CLGs), receive yearly matching grants from the Historic Preservation Fund to ensure that regional, State, and community preservation projects are carried out according to the nationally accepted standards. CLGs are approved by States and receive funding from them.

The National Trust for Historic Preservation, chartered and partially funded by Congress,[13] is also a source of information and expertise about technologies for preservation.

Applying Technologies in Prehistoric and Historic Preservation

Federal agencies can provide a variety of means for encouraging and facilitating the use of new technologies for prehistoric and historic preservation. However, participants in this assessment cited the following impediments to the adoption and widespread use of advanced preservation techniques:

- inadequate experience with and acceptance of new technologies,
- inadequate coordination among and within agencies,
- inadequate funding for technologies,
- inadequate training in the application of technologies, and
- inadequate technical information exchange.

Bird Control Technologies

The imitation snake represents a "low-tech" solution to the problem of damage from bird droppings.

Photo credits: Preservation Assistance Division, National Park Service

The device behind Lincoln's head is an ultrasonic device for preventing birds from roosting on the statue.

---

[9] National Historic Preservation Act, Sec. 202(a)(1).

[10] National Historic Preservation Act, Sec. 202(a)(6).

[11] National Historic Preservation Act, Sec. 106.

[12] National Historic Preservation Act, Sec. 306(a)(1).

[13] The National Historic Preservation Trust Act of 1949 (Public Law 81-408; 63 Stat. 927).

Participants in this assessment cited the critical need to establish a federally funded institution as a mechanism to coordinate research, disseminate information, and provide training about new technologies for preservation. Several institutional structures are possible.

Federal Center for Preservation Technology.—Congress could establish such a center within the Department of the Interior or some other Federal agency. The center would assist the transfer of technology from other areas into prehistoric and historic preservation by developing new applications for existing technologies, providing training for preservation professionals, and serving as a clearinghouse for disseminating information on preservation technologies. A center should have a small but highly trained staff and the facilities for developing technologies relevant to all phases of the preservation process.

A Federal center, based within the Department of the Interior, would have the advantage of consolidating much of the specialized technological expertise now spread throughout the Department of the Interior and other Federal agencies. It could also increase administrative efficiency and lower costs by reducing redundancy of personnel and consolidating overhead. In addition to serving as the focal point for technology-related preservation information within the Federal Government, such an institution would provide needed assistance to State and local governments and to the private sector. All agencies and private individuals and groups would have a central place within the Federal Government to look for technical help with preservation problems.

National Center for Preservation Technology.—Alternatively, Congress could create a National Center for Preservation Technology, outside the Federal Government and managed by a consortium of universities. Such an institution would be able to draw on a multitude of different skills in several universities, and in many university departments. Like the Federal center, it would develop and test new applications of technologies, conduct training, and distribute information. However, it would be free to contract with agencies and with States and the private sector to develop technologies of specific interest to them. Because it would also otherwise be free of the institutional constraints and pressures imposed by being housed within the Federal structure, such an organization might be more innovative than a Federal laboratory. Though a National Center would serve as a resource for the Federal Government, like the Federal center outlined above, it would also serve State and local needs.

The National Astronomical Observatories, which are managed by the Association of Universities for Research in Astronomy, Inc., and funded by the National Science Foundation, might serve as an appropriate model. They not only provide research facilities for the entire astronomical community, but also conduct their own research projects.

Because a national center based in the university community would support Federal preservation efforts, it would require some Federal funding. This option would be an excellent opportunity to strengthen public/private ties for prehistoric and historic preservation, which have always been important features of the preservation movement. Thus, the center could derive a significant percentage of its operating expenses from State and private sources.

Preservation Technology Board.—Additionally, Congress might wish to consider supporting a Preservation Technology Board. Even if one of the two options for creating a Center for Preservation Technology were adopted, a board composed of professionals from all parts of the preservation community would be needed to provide guidance for a center, and to determine current needs for technology, develop standards for the application of new technologies, and assist in disseminating information. The professional societies concerned with archaeology, historic structures, and historic landscapes are likely to be highly supportive of such a Board.

The preservation efforts of the Federal agencies would benefit immeasurably by a Preservation Technology Board. Congress could foster its creation by directing the Federal agencies with major responsibilities for prehistoric and historic preservation to provide initial funding.

Federal Management of Historic Cultural Resources

A thorough assessment of the Federal institutional structure for prehistoric and historic preservation is beyond the scope of this assessment. However, participants in the OTA workshops expressed marked concern over the institutional impediments within the Federal Government that limit its effectiveness in applying a fuller range of technologies to preservation.

The stewardship of prehistoric and historic archaeological resources, historic structures, and historic landscapes has not received sufficient attention within the Department of the Interior. Even within the National Park Service, which carries out many of the Federal responsibilities for prehistoric and historic preservation, the management of programs relating to other Federal, State, and local cultural resources often conflicts with NPS's priorities in caring for natural resources in the Nation's parks. Yet, of the 337 units of the National Park system, two-thirds were established because of their prehistoric and historic resources. All NPS parks contain some prehistoric and historic cultural resources.

In order to implement fully the provisions of historic preservation legislation (table 1), it would be important for the Federal Government, including Congress, to increase its attention to prehistoric and historic preservation. Federal programs have often served as models for the States, local governments, and private preservation efforts.

In view of the concern over the management of the Federal Government's preservation efforts, Congress may wish to consider changing the structure of the Federal Government's preservation efforts. The following paragraphs present options for improving Federal management of cultural resources.

Establish a Separate Agency To Manage and Coordinate All Federal Cultural Programs.—In addition to providing a central focus for all the government's programs in preservation, such an agency would be responsible for administering the National Endowment for the Humanities, the National Endowment for the Arts, and other culturally oriented programs. It would in essence be similar to a Ministry of Culture, which most foreign governments have.

Create an Independent Agency Devoted to the Care and Protection of Prehistoric and Historic Cultural Resources.—Such a policy has the major advantage of providing coherence for the management of U.S. prehistoric and historic preservation programs. It would remove the primary responsibility for cultural resources management from the Department of the Interior, yet it would create a new institution that must be staffed and funded (though many staff, and some funding would result from transfers from existing programs). An independent agency would be the logical place for the Federal Center for Preservation Technology suggested above. However, it would lack the benefits of in-house expertise in the actual ownership and management of historic properties.

Reorganize the Department of the Interior To Provide for an Assistant Secretary for Natural and Cultural Resources.—This option would bring all the cultural programs from NPS and other DOI agencies under the aegis of one office. It would be simpler to effect than creating an independent agency, and would increase the visibility and importance of preservation within the Department of the Interior. However, it would continue the current arrangement of maintaining the preservation function within the department, which as noted earlier, carries disadvantages as well as advantages for the national preservation programs.

Work Within the Current Preservation Structure.—Even if the overall management structure for the Federal preservation effort were left largely unaltered, the agencies could make several changes to improve this Nation's preservation effort, within the direction provided by the National Historic Preservation Act, and other legislation. The initiation and execution of such programs will require direction and continued oversight by Congress. The agencies could:

- inventory their preservation needs and plans for carrying them out;
- develop sustained, organized maintenance programs for historic Federal properties;

- improve coordination and information-sharing among agencies with respect to historic preservation;
- develop a stronger focus on the application of new, efficient technologies for preservation; and
- establish a central office to collect and disseminate information about preservation technologies.

Survey of Prehistoric and Historic Landscapes

The United States has made no comprehensive survey of significant national prehistoric and historic landscapes comparable to its efforts for historic structures. Because prehistoric and historic landscapes are an especially ephemeral resource, some groups are now surveying them. For example, the State of Ohio has an ongoing survey of historic landscapes. New Mexico has also conducted landscape studies.

In 1984 the Historic Preservation Committee of the American Society of Landscape Architects initiated a national survey of historic designed landscapes, which is endorsed by the National Park Service. This important example of a public/private partnership depends primarily on volunteer assistance from many regions of the United States. However, without professional, full-time leadership, relying entirely on volunteers from different regions may lead to inconsistent survey results. The National Park Service could assume a stronger role than it has taken in this effort, in order to assure timely completion of the survey and to standardize the information collected. Congressional oversight may be necessary to assure that this process takes place.

Significant prehistoric and historic landscapes continue to be lost through lack of recognition. The proposed Olmsted Heritage Landscapes Act of 1985[14] (Olmsted Act—H.R. 37), seeks to "encourage the identification, preservation, and commemoration of historic designed landscapes."[15]

Photo credit: HABS/HAER, National Park Service

Cascade area, Meridian Hill Park, Washington, DC

Limited surveys have been conducted on Olmsted landscapes by the National Association of Olmsted Parks and the Massachusetts Association of Olmsted Parks. These primarily volunteer efforts cannot discover all significant Olmsted landscapes. Although the Olmsted Act is directed toward the parks designed by Frederick Law Olmsted's firms, which include some of the most famous and historically significant ~~of~~ U.S. parks,[16] **passage and implementation of the Olmsted Act would materially aid the collection of information on all U.S. historic designed landscapes. Focusing attention on the Olmsted landscapes would also enhance public awareness of other significant landscapes.**

Historic Shipwrecks and Other Submerged Cultural Resources

The United States has not undertaken a national inventory of submerged cultural resources, which include submerged villages and other sites as well as shipwrecks. Although some States have made substantial progress in surveying their own coastal and riverine areas, and locating submerged resources, no States have comprehensive data on file.

---

[14] See, however, *The National Historic Preservation Act: An Assessment* (Washington, DC: Advisory Council on Historic Preservation, September 1986) for a discussion of many of the broader institutional issues faced by preservation efforts in this country.

[15] Sec. 4 of H.R. 37.

[16] Over three generations, the Olmsted firms, whose Brookline, MA, office is now a National Historic Site, managed by the National Park Service, designed such parks as Central Park in New York City, Franklin Park in Brookline, MA, and Prospect Park in Brooklyn, NY, as well as estates, universities, park systems, institutional properties, and urban plans.

Historic shipwrecks in coastal waters contain a wealth of important information concerning the exploration and settlement of this country. Yet efforts to protect them for research and public interpretation are hampered by current Admiralty Laws, under which historic shipwrecks are treated as abandoned property. Their contents may be recovered by salvors. Such recovery often destroys valuable information related to the Nation's maritime history. **Passage and implementation of the proposed Abandoned Shipwrecks Act (H.R. 3558/S. 2569) would make it possible to preserve significant historic shipwrecks for future generations by ceding jurisdiction, ownership, and oversight of them to the States.** The Senate version is almost identical to the House version, and maintains incentives for sportdivers and salvors to continue searching for historic shipwrecks. It would also guarantee salvors "reasonable compensation" for work undertaken under its terms.

The important additional attention to submerged prehistoric and historic cultural resources that passage of the Abandoned Shipwrecks Act implies may require the National Park Service and the National Oceanic and Atmospheric Administration to increase their funding and other support of submerged cultural resources activities.

Photo credit: Submerged Cultural Resources Unit (SCRU) National Park Service

Stop 6 on underwater trail in Isle Royale National Park, Lake Superior, Michigan. Photo shows diver preparing to attach marker to the wreckage of the passenger/package freighter *Monarch* that went down in a storm in December 1906.

Congressional oversight may be necessary to guarantee that such requirements are met.

Protection of Prehistoric and Historic Cultural Resources

Looting and vandalism are serious threats to the management and conservation of prehistoric and historic cultural resources. The activities of looters are particularly damaging to prehistoric sites because they destroy important and valuable scientific information. Painting graffiti, breaking windows, destroying shrubs, and other acts of vandalism reduce the value of historic structures and landscapes and make them much less attractive to visitors. Advanced monitoring and observation devices may aid the law enforcement process. However, they cannot substitute for the presence of trained officers in the field. Adaptive reuse of cultural resources imparts a natural element of protection by giving them value beyond their historic value.

The high value placed on some items in national and international markets and the lack of consistent law enforcement in dealing with illicit excavation on public lands and trafficking in stolen artifacts, make protection of sites and structures as well as prosecution for illegal activities extremely difficult. Professional thieves are technologically well-equipped and motivated by strong economic incentives to continue their activities. **In addition to employing trained personnel and applying appropriate technologies, the United States needs to improve the enforcement of its policies for dealing with illicit excavation and trafficking in stolen artifacts.** Congressional oversight of the implementation of existing legislation may be necessary to encourage such enforcement.

Recent technological advances could enable relatively easy registration and coding of artifacts for sale. To assist in stemming the illegal loss of irreplaceable artifacts from public lands, and the concomitant damage that looting causes, **it may be appropriate to amend the Archaeological Resources Protection Act of 1979 and other statutes to permit private registration of antiquities obtained in the course of archaeological excavations, conducted by trained archaeologists on**

private land. Registration would make it easier for law enforcement officials to obtain convictions for illegal sale of unregistered artifacts taken from public lands, by shifting the burden of proof that the artifact was dug on private land from the government to its owner. To be most effective, registration should include sufficient information about the artifact to allow the owner to understand its archaeological origins and connection to the prehistoric peoples from which it derives.

Registration of scientifically excavated artifacts is likely to enhance the value of registered artifacts relative to unregistered ones. Such increase in value might provide economic incentives for private landowners to have their sites properly excavated and recorded, rather than dug solely for their marketable artifacts. Registration might also assist in educating landowners to the scientific value of using the best possible excavation methods. However, sale of artifacts from excavations would have the disadvantage of dispersing some collections, rendering them less available for restudy.

The Convention on Cultural Property Implementation Act[17] prohibits importation of stolen cultural property that is documented as belonging to the inventory of a public monument, museum, or similar institution in a State party to the UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property.[18] It also restricts archaeological or ethnological materials from other countries upon request and subsequent agreement by the United States. However, it is just being implemented and further experience will be needed to test its efficacy in stemming the international flow of cultural property.

U.S. law does not protect against export of irreplaceable items of U.S. cultural history from the United States to other countries. The UNESCO Convention encourages each State party to register cultural property[19] for the purposes of controlling import into other countries. **As experience is gained with implementing the Convention on Cultural Property Implementation Act, it may be appropriate for the United States to explore ways in which the registration of artifacts suggested above could be expanded to other prehistoric and historic cultural property for international trade.**

---

[17] Public Law 97-446.

[18] Fifty-eight countries have signed the UNESCO Convention.

[19] See articles 6 and 10 of the UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property.

THE PRESERVATION PROCESS

The process of sound cultural resource research and management is extremely complex and involves individuals from a variety of disciplines. It can be divided into the following components, which are not necessarily listed in order of application:

- discovery (identification and survey);
- recording and measurement;
- analysis and evaluation;
- restoration, conservation, and maintenance;
- protection from catastrophic losses;
- data and information storage and retrieval; and
- public education and involvement.

These components make use of a broad array of rudimentary, as well as sophisticated, technologies. Many new technologies promise to enhance the process of prehistoric and historic preservation. However, they must be appropriate to the task to which they are applied. In some cases, traditional methods (so-called low-tech solutions) may be the most appropriate and cost-effective.

Discovery

Archival investigation is an important first step in the discovery phase of the preservation process. Before beginning actual fieldwork, archival materials and oral histories related to the project should be collected and studied. They are especially helpful in focusing the research problem and aiding creation of a detailed research plan. Efficient data management systems are needed

Box A.—Some Research Technologies Discussed in the Report

Discovery

Remote Sensing.—Includes techniques of imaging Earth from spacecraft and aircraft. Also includes surface methods and geophysical methods that penetrate below the surface of the Earth, or underwater.

Aircraft and spacecraft methods:

- *photography*: black and white, color, and infrared at a wide variety of scales;
- *multispectral scanning*: electronic sensing and processing of visual images in many spectral bands, including infrared; and
- *imaging radar*: builds image of surface topography by analyzing a series of microwave radar scans. It can even be used to penetrate below the surface of dry soil;

Subsurface methods:

- *georadar*: detects reflections of microwaves, transmitted by radar carried along the surface, from cultural material below the surface;
- *soil resistivity meter*: measures electrical resistance of soil to the passage of a small current from probes placed in soil; cultural material generally displays different resistance from surrounding soil;
- *soil conductivity meter*: measures conduction of current passed between two probes placed in soil; cultural material generally displays different conductivity from surrounding soil;
- *magnetometer*: registers changes in the local magnetic field as detector passes over iron-bearing cultural material; and
- *metal detector*: finds subsurface metals by detecting small electric currents (eddy currents) generated in the metal by electromagnetic pulses transmitted by the instrument.

Underwater methods:

- *side-scan sonar*: locates shipwrecks and sites on the bottom surface by detecting the echoes of high-frequency acoustic pulses transmitted from instrument towed behind ship;
- *sub-bottom profiler*: locates shipwrecks and sites below the ocean bottom by detecting the return signals of lower frequency acoustic pulses from instrument towed behind ship;
- *magnetometer:* similar in principle to the magnetometer for use on land. It detects changes in the magnetic field as detector passes over iron-bearing cultural material. It can be used from a ship or an airplane; and
- *remotely operated vehicles (ROVs)*: a variety of submersible vehicles that can carry photographic or video cameras to image submerged objects. ROVs can also retrieve samples from the bottom.

Surface methods:

- *video*: color and black and white; and
- *photographic cameras*: can be operated in infrared as well as color and black and white.

Predictive Locational Modeling.—This term is applied to a group of techniques, often requiring a computer, employed to predict the distribution of archaeologically significant material in a region by analyzing such factors as climate, soil characteristics, landform characteristics, and the availability of crops and game.

Documentation

Photogrammetry.—This precision recording technique makes use of a stereo pair of photographs, the details of which are analyzed in a stereo comparator and plotted on a precision plotter. Most recent versions of the method, called analytical plotting, make use of computers to assume most or all of the burden of analyzing the stereo photographs. The method can be used to record extremely fine details of a site, structure, or landscape for later three-dimensional analysis.

Close-Range Inspection.—This includes a variety of techniques for studying the surfaces or interiors of structures in detail. In addition to visual analysis under bright light, or photography, such methods include:

- *infrared inspection*: the use of infrared light and infrared sensors to reveal surface detail invisible to the naked eye;
- *ultraviolet inspection*: the use of ultraviolet light (often called black light) to reveal surface detail invisible to the naked eye;
- *X-ray inspection:* the use of X-rays to explore the interior of structural material (primarily plaster and wood);
- *neutron-gamma ray inspection*: the use of neutron-emitting radioactive sources to determine the chemical constituents of structural materials. High energy neutrons strike atoms of structural material causing them to emit gamma rays characteristic of the material. Analysis of the energies of the detected gamma rays can be used, for example, to determine the kinds, distributions, and amounts of contaminants within structural materials without cutting, coring, or otherwise disturbing them.

Archival

Information Systems.—Computer technology makes nationwide links between archives and libraries possible. Keyword systems allow efficient searches for materials that may be located in many different places. They also permit the listing of diverse kinds of archival and library holdings, such as papers, maps, photographs, charts, books and films, under one subject heading.

Optical Disk Storage.—Optical, or laser, disk storage is a highly powerful medium for storing and retrieving large amounts of visual, print, and voice data quickly. It works much like a compact record disk, using a small laser to read the disk's surface, but can store and display full motion video as well as still photographs and text. A single optical disk can now store approximately 54,000 single images on one side.

Analysis

Geographic Information Systems (GIS).—These are computerized database systems in which the data are explicitly spatial in nature and organization. They can be used to accumulate many kinds of data, such as soil type, distribution of sites or structures, plant type, and population distribution and display them in a variety of ways to reveal patterns of settlement, land use, or other spatial patterns.

Dating Techniques.—A wide variety of direct dating techniques are available that use chemical, physical, or visual analysis.

- *dendrochronology*: commonly known as tree ring dating, this technique relys on the fact that climate, water, and soil conditions make trees grow at different rates from year to year. Visual inspection of the patterns of tree rings yield highly accurate cutting dates for logs.
- *radiocarbon*: depends on the slow decay of carbon-14 in organic compounds. The amount of carbon-14 in organic materials remains in equilibrium with the atmosphere while organisms are still alive. The approximate date they die can be determined by measuring the current ratio of carbon-14 to carbon-12 in samples.
- *archaeomagnetism*: depends on the slight change of direction and strength of Earth's magnetic field over time. Iron-bearing particles, when heated, for example in a fire hearth, become free to assume the magnetic direction of the local field of the Earth. After the hearth cools, the magnetic field of that epoch is sealed in the iron-bearing material. Comparison of the sample's magnetic field direction with the present magnetic field yields an estimate of the sample's age.
- *obsidian hydration*: depends on the fact that the outer surfaces of freshly flaked obsidian will take on water from the atmosphere over time. By measuring the amount of water in the outer layers of a sample of obsidian, it is possible to estimate how long ago an obsidian flake was made.

NOTE: This list is illustrative of the many technologies applicable to preservation rather than comprehensive. Most of the technologies in this brief list can be applied in other phases of the research process than those for which they are listed. For example, although predictive locational modeling is listed as a technology for discovery, it is also a potentially powerful analytic tool.

for archival investigation. These include subject-accessible keyword systems and finding aids that relate to the geographic location of sites. Careful notation of the field survey and inventory data for later use and archival storage requires the design of collection forms that can be easily read by automated information systems.[20]

Remote sensing techniques using both aircraft and spacecraft, as well as close-range sensors, appear to offer great promise in extending our ability to discover, characterize, and study archaeological sites and historic landscapes. Yet, high costs of equipment and lack of familiarity with remote sensing techniques have inhibited their use in archaeology and landscape studies. Although remote sensing techniques are little used in identifying historic structures, they can improve our understanding of the significance of these structures by revealing new contextual information.

Geographic information systems and predictive modeling methods are also finding utility for survey and identification of archaeological sites and landscapes. Ultimately, locational predictive modeling techniques, analytical tools for predicting the distribution of archaeologically significant material across large regions, are likely to prove powerful aids for research and management of cultural resources, especially in the vast public lands of the Southwest and West. However, such models need considerable refinement, and may never reduce the overall costs of surveying and identifying archaeological sites.

Underwater archaeology depends primarily on technologies borrowed from the oil and gas exploration industry. The costs of using such survey technologies as side-scan sonar, sub-bottom profilers, remotely operated vehicles, and precision positioning systems are likely to remain extremely high. However, the data for initial surveys in shallow coastal waters may be available from the exploration firms and the Minerals Management Service at extremely low cost. Magnetometry, the most widely used of underwater locational technologies is less costly, but responds only to ferrous material. Using airborne magnetometers would reduce the costs of surveys by allowing rapid coverage of large areas of water.

Video technology, because it is relatively simple and inexpensive to use has broad applications for survey and identification, can store vast amounts of information about the context of his-

Radar Image of Death Valley, California

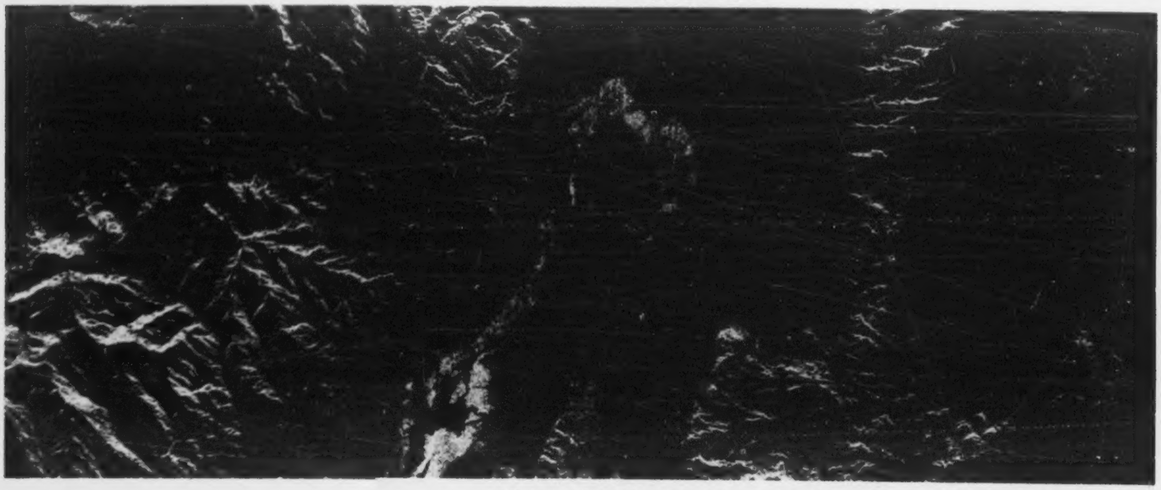


Photo credit: Jet Propulsion Laboratory and National Aeronautics and Space Administration

A variety of geologic features can be seen in this radar image acquired by the Shuttle Imaging Radar-B carried aboard the space shuttle, Oct. 11, 1984.

---

[20] For example, the Wisconsin State Historic Preservation Office has devised a sites and structures form, which can be read efficiently by an optical character reader.

toric structures, and is capable of imparting a sense of presence, place, and context that individual photographs cannot. It has also found considerable use in underwater archaeology, for survey and interpretation of submerged resources to the public.

During the last two decades, significant strides have been made in the drive to recognize significant landscapes. However, only within the last year have landscapes been incorporated within the significance categories for the National Register of Historic Places.[21] Such an omission has constituted a major barrier to nominating landscapes to the Register.

Recording and Measurement

Photogrammetric stereo recording of archaeological sites, historic buildings, and landscapes is underutilized in the United States, in large part because of a lack of appreciation of its benefits in heightened accuracy and speed of execution, as well as the requirement for trained staff and specialized equipment. Recent advances in computer software, brought about by extensive research on remote sensing from aircraft and spacecraft, coupled with relatively inexpensive image digitizers, promise to lower costs dramatically. Stereo photogrammetric techniques are also being applied to documenting submerged cultural resources.

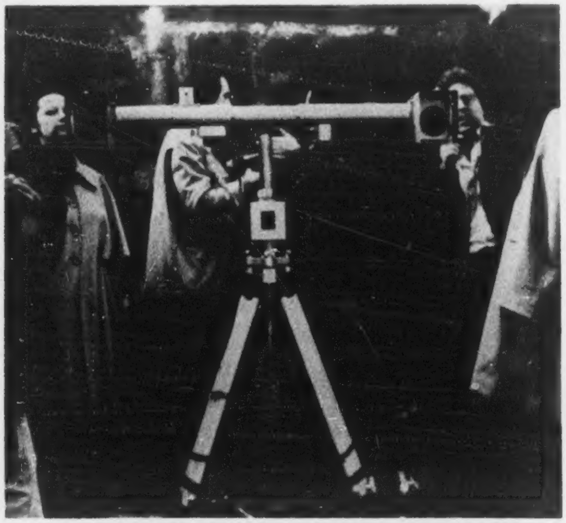


Photo credit: Preservation Assistance Division, National Park Service

Stereo photogrammetry in Rome

Excavation is necessarily destructive. There is therefore a strong need to improve the quantity and quality of archaeological data recording. It is also important to refine the techniques for locating the most suitable sites for excavation. **Many experts feel that archaeologists need to excavate less and record sites more carefully. They might also benefit from standardizing the process of gathering data so there is less onsite analysis.** Microanalytic soil and plant techniques have improved dramatically in the past decade. In addition to storing records and artifacts, archaeologists would benefit from saving soil samples, corings, and excavation profiles for future reanalysis of sites when techniques have improved still further.

Underwater archaeologists need greater access to the dramatically improved deepwater remotely operated exploratory vessels developed for the U.S. Navy, and the oil, gas, and mineral industries. Because submerged wooden vessels, the largest of all artifacts, are extremely fragile, they would also benefit from the development of technologies that would enable shipwrecks to be examined and their contents excavated with minimal disturbance to the structures themselves.

The detailed examination of the surfaces of historic structures benefits immeasurably by using infrared and ultraviolet techniques. X-ray and neutron-gamma ray devices make possible the nondestructive examination of internal or hidden structural details.

Optical disk technology allows the storage and retrieval of diverse kinds of information on all preservation issues. Photographs, videos, test results, field notes, and other kinds of information can be stored together in one place to facilitate access.

---

[21] See J. Timothy Keller and Genevieve P. Keller, "How To Evaluate and Nominate Designed Historic Landscapes," Bulletin #18, National Park Service, 1986. This document represents the first attempt within the U.S. preservation movement formally to signify the importance of landscapes to the U.S. cultural heritage. The preservation of cultural landscapes has also received relatively little attention. See Robert Z. Melnick, *Cultural Landscapes: Rural Historic Districts Within the National Park Service* (Washington, DC: National Park Service, U.S. Department of the Interior, 1984).

Analysis and Evaluation

Accurate dating of archaeological materials plays an important part in understanding prehistoric cultures. The several dating techniques developed for archaeology are excellent examples of the transfer of technology from the natural sciences into archaeology. Traditional radiocarbon dating techniques, which were developed by chemists, have proved powerful tools for determining the ages of organic material. However, because many of the artifacts archaeologists wish to date are extremely small, they are limited by the amount of the sample (about a gram) needed compared to the size and mass of the artifacts. Recent advances in radiocarbon dating yield acceptable results with samples 1,000 to 1 million times smaller. Other advances in dating techniques, such as archaeomagnetic dating, which was developed by geophysicists and depends on measuring changes in the Earth's magnetic field over time, have dramatically extended the archaeologists' ability to date archaeological remains.

Archaeologists have usefully applied the analytical techniques derived from soil science and geomorphology for many years. Techniques derived from the earth sciences have much to contribute to the management of archaeological sites and historic landscapes. Continued improvements in such techniques will be important in assisting the research of archaeologists and landscape historians.

Landscapes are subtle and constantly changing as a result of both natural and human processes. Computer modeling and remote sensing techniques provide a powerful set of techniques for the analysis and evaluation of large-scale landscapes. Analysis of landscapes requires understanding of plant types and plant variations. For historic gardens, the identification and retrieval of historic plant types is particularly important. There is a strong need to develop databases on the types of plantings used historically. Such databases will also depend on maintaining archives on the types of plants used historically in the United States.

Even though historic structures were built in stages and are composed of many different subsystems, they nevertheless function as a total interdependent system. **It is essential to analyze their performance as a whole, rather than a sum of independent component parts.** Architects must be trained correctly to analyze and predict the behavior of structural elements over time in different environmental conditions. Structures also exist as part of a total landscape and should be analyzed within that context rather than being considered independent of their surroundings.

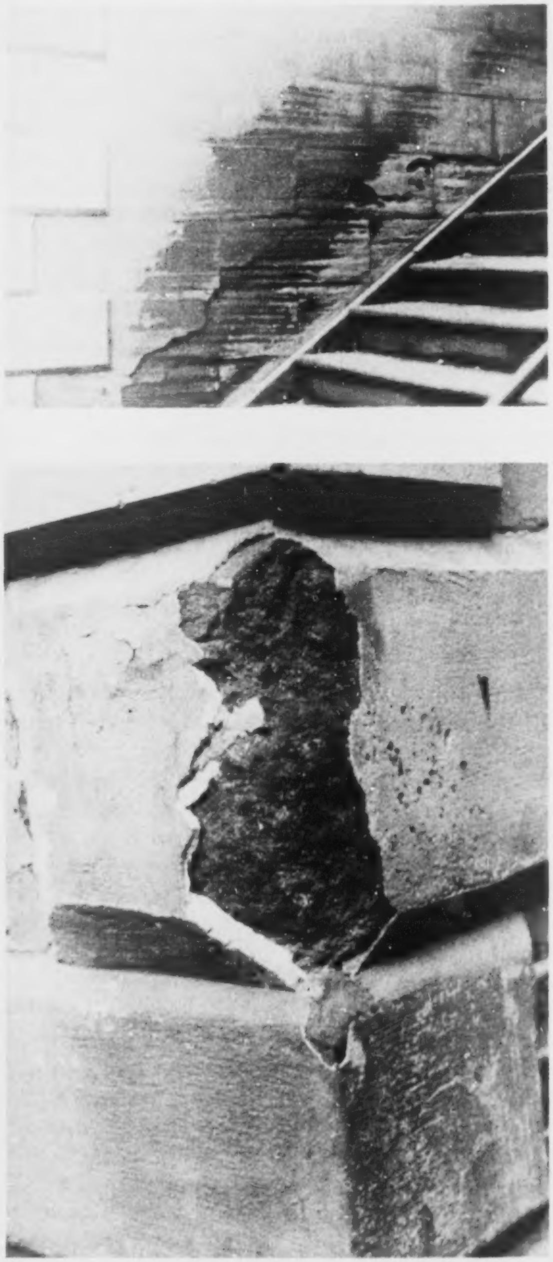
Considerably more progress is needed in nondestructive assessment of structural condition. X-ray and gamma-ray devices can locate hidden features of structures. They can also be used to determine and diagnose moisture and deterioration of structural elements.

Restoration, Conservation, and Maintenance

Regular, periodic maintenance plays a crucial part in conserving prehistoric and historic sites, structures, and landscapes and enhances their value. **Yet relatively little attention has been given to training for maintenance** or **applying technology to improving maintenance management.** Long-range management is especially important. Expert systems and optical disk technology can vastly improve the delivery of quality training in restoration, repair, and maintenance. Craftspeople skilled in restoration techniques should be made part of the decisionmaking process for restoration, conservation, and maintenance. Proper cyclic maintenance for sites, structures, and landscapes includes a thorough understanding of both traditional and advanced techniques.

Materials recovered from submerged sites pose particularly difficult conservation problems. They become highly vulnerable to the process of decomposition almost immediately after being removed from the water, and require perpetual, not just cyclic, attention.

Because local residents often have a major stake in the subsequent use of a preservation project, they should be consulted during the analysis of sites, structures, or landscapes prior to restoration. A variety of analytic interview techniques speed this process and make it more ac-



Structural Damage

Photo credits: Preservation Assistance Division, National Park Service

Upper photo, brownstone deterioration as a result of splashback from traffic on stairs. Lower photo, ice damage to stone.

curate. It is also important to gather and store interview materials properly in archives so they may be used effectively.

Participants in this assessment noted that **many contemporary buildings reflect inadequate knowledge of materials and construction methods. They could become the preservation problems of the future.** It is important to give more attention both to understanding materials and developing standards for construction. Information that is collected in the investigation of historic building materials may be extremely useful for refining current building techniques and developing proper maintenance plans. In particular, **reinforced concrete, one of the most common of building materials, is failing in both modern and historic structures because its behavior has not been well understood. Reinforced concrete constitutes a growing and burdensome conservation problem for the future.** Effective conservation treatments should be found and that information widely shared.

Environmental stresses on historic structures have increased markedly in the last century. Technologies for conserving historic structures against rapidly accelerating degradation by chemicals and water in the atmosphere and soil are needed.

In an effort to reduce costs, or meet local building codes, substitute materials are often employed in restoring historic structures. The behavior of these substitute materials also requires detailed analysis before they are used in order to assure that they will last and will be compatible with the original materials and appropriate to the structure.

The Federal effort at stabilizing and conserving prehistoric and historic sites and structures suffers from lack of agency coordination. Considerably more research needs to be done, for example, on technologies for site monitoring, and the stabilization of adobe, stone, and wood.

The conservation of prehistoric and historic rock art[22] has received very little attention from

---

[22] Rock art includes rock painting (pictographs) and rock carving, incising, and pecking (petroglyphs).

Federal agencies. **Because of the importance of rock art to understanding prehistoric Native American culture, a focused effort to develop appropriate conservation technologies is very important.** Conservation of rock art is also important to many contemporary Native Americans as it is part of their cultural heritage.

As a result of the multitude of stresses that the urbanization of the United States places on the natural environment, it is more important than ever to identify and manage significant prehistoric and historic landscapes. **The United States is losing significant numbers of historic plant species. In order to reduce such losses, and make it possible to restore historic gardens accurately, it may be necessary to establish arboretums to conserve and propagate historic plant species.** Arboretums, such as the one at Jefferson's home, Monticello, and many historic gardens, could also play an important role in maintaining the diversity of plant species.

Records that document the maintenance and preservation of sites, structures, or landscapes can be used to make informed decisions about which technologies will work best and be most cost-effective. Yet such important documents are often not retained because they are considered unimportant as "housekeeping" information.

Protection From Catastrophic Losses

Prehistoric and historic sites, structures, and landscapes are subject to a variety of catastrophic losses, including fire, earthquake, looting, and vandalism. **Under certain circumstances, technologies for the detection and surveillance of intruders and potential arsonists or vandals can enhance the protection of cultural resources. However, the costs of such technologies are extremely high. In addition, patrols by trained law enforcement officials are also necessary.** Urban, rural, and underwater environments require different approaches to law enforcement. Public educational and other regular and constant uses of historic properties can contribute to their protection by ensuring that people are often present at times of high potential risk.

Cultural resources on Federal lands belong to the Nation and are held in trust by Federal agencies for the benefit and enjoyment of all citizens. Increasing the effectiveness of law enforcement for the protection of cultural resources on Federal lands will require better coordination among Federal agencies for training and sharing of information.

Methods for protecting historic structures located within earthquake zones, particularly in cities, has begun and should continue. However, historic structures are more frequently lost from neglect than from catastrophic events. Some are deliberately destroyed by their owners because they have little notion of why they should be preserved.

Historic structures are particularly vulnerable to arson and intrusion. Devices designed to monitor for fire and intrusion must be simple to operate and maintain. Those that can be operated and understood only by trained experts may do more harm than good if they malfunction or create a false sense of security.

Preservation Information

Efficient access to information remains one of the greatest impediments to effective management of cultural resources. New means of recording, storing, retrieving, and manipulating data and information promise to improve dramatically our ability to identify and preserve significant prehistoric and historic sites, structures, and landscapes. The most consequential advances are expected from the application of optical disk technology in various forms, which will allow the storage and retrieval of prints, photographs, and video as well as text. Optical character readers for translating text to machine readable format will improve preservationists' ability to create databases and enhance the flow of information. However, making effective use of such technologies will require the development of standardized formats for data collection and recording. Improved coordination within the preservation community could assist the development of such standards.

Participants in this study expressed considerable concern about the long-term stability and storage quality of new data and information media and equipment. **It will be essential to con-**

Photo credit: Jack Boucher, National Park Service

Carson House, Eureka, California

tinue to study the longevity of such media and equipment and to develop systems that are evolutionary, rather than revolutionary, in order to reduce the costs and disruption to records that abrupt technological shifts might cause.

Public Education

Public education and interpretation are among the most effective means of preserving prehistoric and historic sites, structures, and landscapes for future generations to enjoy. Long-term storage issues aside, creative use of video and interactive optical disk technologies can significantly enhance the quality of preservation education and interpretation. Electronic media make possible public involvement with the educational materials because they allow direct interaction with the media. Programs on optical disks, especially, could encourage viewers to select different paths of information and to individualize their educational experience.

Many people are simply not aware of the threat that vandalism and looting pose for this country's cultural resources. Improved education concerning the benefits of preserving our cultural resources would enhance efforts to protect them.

The Federal Government should take a leading role in educating citizens about the loss of U.S. cultural resources and what they can do to help preserve them. It should also demonstrate strong management policies with respect to the properties it oversees.

Museums are a major source of public education about U.S. cultural resources. Yet they often fail to inform the public adequately on the need to preserve prehistoric and historic cultural resources. They should be encouraged to provide better education concerning the threats to cultural resources in the United States and abroad. This may require modest amounts of additional funding for museums.

Techniques that allow the public to observe safely the course of an excavation or restoration add significantly to its understanding and sympathy for the goals of prehistoric and historic preservation. The process itself then functions as an educational tool.

Historians can provide the broad historical context needed for interpreting the past. Historians, particularly those involved in public history studies and programs, should be involved in the interpretation process from its beginning through production of the end product or performance.

SOURDOUGH
HOT MEALS
CAFE
COLD DRINKS
OPEN

Photo credit: Robert L. Spude, National Park Service

Sourdough Roadhouse, Alaska, a National Historic Landmark. This roadhouse was built on the trail from Valdez on the coast to the gold fields of Fairbanks, the trail that parallels the Alaskan pipeline today. The roadhouse has been operating continuously since ca.1905, when it was built.

Chapter 2

Background

Contents

Page
Introduction 29

Preparation of This Report 30
  Technologies for Preserving Archaeological Sites and Structures 30
  Technologies for Underwater Archaeology and Maritime Preservation 31
  Technologies for Preserving Historic Structures 32
  Technologies for Preserving Planned Landscapes and Other Outdoor Sites . . 33
  Technologies for the Physical Protection of Prehistoric and Historic Sites 34

Common Preservation Issues 34

A Centralized Conservation Facility 38

Organization of the Report 39
  The Chapters 39

List of Tables

Table No. *Page*
2. Representative Prehistoric and Historic Archaeological Sites 31
3. Representative Disciplines Participating in Prehistoric and Historic Preservation 31
4. Areas of Significance and Activity Represented by Historic Structures 33

Chapter 2

Background

INTRODUCTION

In recognition of the growing importance of preserving our prehistoric and historic heritage, over the last 80 years Congress has enacted a variety of laws to protect and preserve U.S. cultural resources. These laws include, among others, The Antiquities Act of 1906,[1] The Historic Sites Act of 1935,[2] The National Historic Preservation Act of 1966, as amended in 1980,[3] The Archaeological and Historical Preservation Act of 1974,[4] and The Archaeological Resources Protection Act of 1979.[5] The ability of Federal agencies to carry out provisions of these laws rests increasingly on discovering and using cost-effective advanced techniques, methods, and equipment for prehistoric and historic preservation.[6]

Nearly every congressional district contains federally managed prehistoric and historic structures, landscapes, and archaeological sites. This assessment was requested by the House Committee on Interior and Insular Affairs to assist the Committee's legislative authorization and oversight of Federal preservation efforts.[7] The Subcommittee on Public Lands has initiated a major oversight review of the national historic preservation program. The results of this assessment should support the Subcommittee's efforts to review how the use of technology, including methods and techniques, as well as tools and equipment, can assist historic preservation. In this report, **preservation technology refers broadly to any equipment, methods, and techniques that can be applied to the location, analysis, interpretation, management, conservation, and protection of prehistoric and historic sites, structures, and landscapes.**

In order for preservation professionals and the general public to appreciate and learn from the record of past human behavior, these cultural resources must be preserved for both the present and the future. As the National Historic Preservation Act notes:

> . . . the preservation of this irreplaceable heritage is in the public interest so that its vital legacy of cultural, educational, esthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Americans.[8]

Yet, in recent years the stresses on cultural resources have increased dramatically. The identification of such stresses and the desire to limit their deleterious effects has led to an increased interest in the development of technologies for prehistoric and historic preservation.

This report provides an overview of preservation technologies. It also assesses a variety of policy options related to the use of these technologies and suggests improvements in implementing current policy. More specifically, the report: 1) identifies and discusses effective current technologies for prehistoric and historic preservation; 2) evaluates promising new technologies that could be applied; and 3) suggests areas for research and development. The report also identifies and assesses nontechnical constraints on the use of technologies. Finally, it explores the use of preservation technology in other countries.

---

[1] Public Law 59-209; Stat. 335; 16 U.S.C. 431-433.

[2] Public Law 74-292; 49 Stat. 666; 16 U.S.C. 641-467.

[3] Public Law 89-665; 810 Stat. 915; 16 U.S.C. 470.

[4] Public Law 93-291; 88 Stat. 174.

[5] Public Law 96-95; 93 Stat. 712; 16 U.S.C. 470.

[6] See U.S. Department of the Interior, "The Resource Protection Planning Process," Preservation Planning Series, September 1980, for concepts that define historic preservation.

[7] "The physical remains of our heritage, both prehistoric and historic, are unique, non-renewable resources. It may be that new methods and technologies, including some of those developed in the space program and other high technology endeavors, could be put to use to help us better understand and manage these resources and the information they can provide us. Accordingly, we ask that the Office of Technology Assessment undertake a study of technologies for the identification, recordation, interpretation, protection and management of prehistoric and historic sites." From the requesting letter, Sept. 10, 1985, signed by Morris K. Udall, Chairman, Don Young, Ranking Republican Member, John F. Seiberling, Chairman, Subcommittee on Public Lands, and Ron Marlenee, Subcommittee Ranking Republican Member.

[8] National Historic Preservation Act of 1966, as amended, Sec. 1(b) (Purpose of the Act), para. 4.

The assessment focused on technologies for: 1) locating, identifying, surveying, and analyzing prehistoric and historic structures, sites, and landscapes; and 2) conserving and protecting them. It does not address the preservation of paintings, books, and other artifacts. except insofar as technologies used for their preservation are applicable to structures, sites, and landscapes. The assessment also considers technologies for storing, sharing, and retrieving historic preservation information.

PREPARATION OF THIS REPORT

In order to identify and refine the many preservation issues discussed in this report, OTA convened a series of five workshops, held at OTA between December 1985 and April 1986. For each workshop, OTA selected participants from government, academia, and private enterprise with a broad range of expertise in the use of preservation techniques, and experience in public policy. Observers from a variety of Federal agencies and public and professional interest groups also attended and contributed to the discussion.

Each workshop identified and examined preservation technologies appropriate to the specific subject under discussion, and discussed impediments to their effective use. Workshop participants developed and discussed a long list of issues related to the use of technologies for prehistoric and historic preservation. They also examined how Federal, State, and local agencies, the universities, and the private sector use preservation technologies, and suggested a variety of options for improving historic preservation policy and implementation.

Technologies for Preserving Archaeological Sites and Structures

Many U.S. prehistoric and historic cultural resources in the United States are buried or submerged. This workshop identified and examined technologies for locating, recording, analyzing, and preserving archaeological sites. It dealt only briefly with underwater archaeology.

Archaeology is the scientific study of structures, artifacts, and other material remains of earlier peoples, and of the ways in which they adjusted to their environments and modified the landscape. The results of such studies enable archaeologists to draw inferences about past human activities and behavior. In the Americas, prehistoric archaeology refers to the study of cultural materials from native peoples who inhabited these continents prior to about A.D. 1500.[9] Historic archaeology treats materials of peoples who have lived in the historic period, for whom written records also exist.

Although curiosity with regard to the practices of other cultures plays a strong motivating part in the discipline of archaeology, the opportunity to broaden our understanding of how people have responded to the challenge of wresting a living from the Earth is also important. Both prehistoric and historic archaeology share the goals of locating, analyzing, and protecting cultural material. Sites, or loci of concentrated human activity,[10] which are the focus of much archaeological research, may range from a simple surface scatter of stone tools and toolmaking remains to a complex of wood and stone structures covering many acres (table 2). They may be found on the surface, partially covered by earth or water, or entirely buried or submerged. All sites include, as an important part of their makeup and meaning, some portion of the surrounding landscape.

---

[9] The precise delineation between prehistoric and historic periods varies depending on the region under consideration.

[10] Some archaeologists have argued that because the boundaries of any given site are arbitrary, and that the definition of a site depends on regional analysis, the site concept is deficient as a research and management tool. See, for example, R.C. Dunnell and William S. Dancy, "The Siteless Survey: A Regional Scale Data Collection Strategy," *Advances in Archaeological Method and Theory*, vol. No. 5, Michael B. Schiffer (ed.) (New York: Academic Press, 1983), pp. 267-287. Although OTA recognizes the term's limitations in adequately reflecting the object of archaeological research, OTA nevertheless uses it for this study in the absence of a more precise and generally accepted term.

Table 2.—Representative Prehistoric and Historic Archaeological Sites

- agricultural terraces, canals, and raised field systems
- battlegrounds
- boats
- burials
- causeways
- cities
- dwellings
- farmsteads
- fences and stone walls
- field houses
- footpaths
- gardens
- hunting blinds
- hunting camps
- kill sites
- lithic scatters
- manufacturing sites
- mills
- mounds and earthworks
- plant processing sites
- quarries
- ritual structures
- roadways
- rock art sites
- ships
- stone alignments and forms
- stone fences, corrals, fishweirs
- submerged villages
- trash dumps
- villages and towns
- water control features

SOURCE: Office of Technology Assessment, 1986.

Archaeological research and preservation are extremely complex and involve individuals from a variety of disciplines (table 3). They are also highly labor-intensive. Much archaeological research involves excavation in which scores of laborers are required to dig, sift, examine, and collect a variety of cultural and environmental remains. Archaeological analyses require the curation, storage, and handling of many kinds of information and artifacts, as well as consideration of many different ecological and cultural variables.

Prior to proceeding with fieldwork, archaeologists must develop a research rationale and plan appropriate to the archaeological resources under investigation. Archaeologists depend on the development of technologies that simplify the process of gathering and processing data and improve the quality of archaeological information. Such developments are especially welcome if they lead to lower costs.

Table 3.—Representative Disciplines Participating in Prehistoric and Historic Preservation

- anthropology
- archaeology
- architectural history
- architecture
- art history
- astronomy
- biology (including palynology)
- botany
- chemistry
- climatology
- ecology
- engineering
- folklore
- geography
- geology
- geomorphology
- geophysics
- history
- hydrology
- land planning
- landscape architecture
- maritime history
- materials science
- physics
- volcanology
- zoology

SOURCE: Office of Technology Assessment, 1986.

Archaeologists have a strong interest as well as a responsibility to preserve sites even after they have been excavated, as archaeological data still remain in the architecture and in the cultural deposits not excavated in the site.[11] In addition, considerable information may exist in the site for which extraction techniques have not been developed.[12]

Technologies for Underwater Archaeology and Maritime Preservation

Because the technologies for locating, surveying, analyzing, and protecting submerged cultural resources differ substantially from those used on land-based archaeological sites, OTA convened a separate workshop to consider them. This workshop discussed the special problems related to underwater archaeology and maritime preservation.

The specialty of underwater archaeology has developed in the last three decades and still has relatively few qualified practitioners.[13] The study of underwater prehistoric and historic cultural materials is possible in large part because a variety of advanced technologies have been brought to bear on the identification, recovery, analysis, and conservation of these important remants of U.S. heritage. Such resources may include not only shipwrecks and their contents, but also inundated villages, towns, even cities, farms, warehouses, piers, and wells. They may also include sites that were once submerged, but are now located under dry land after a change in the course of a river channel, or those incorporated within landfill extensions. As one archaeologist, who specializes in studying submerged cultural resources has put it:

---

[11] As a result of the expense of excavation, as well as the desire to preserve as much information as possible for future archaeologists to study, few sites are ever totally excavated (see *Chapter 3: Research*, for further discussion of this point).

[12] For example, archaeomagnetic dating techniques (see *Chapter 3: Research*) were not developed until the 1970s. Yet many sites excavated before the 1970s could yield additional information by using such techniques on them today.

[13] Before the 1960s, less than a dozen scientists were engaged in underwater archaeological activities anywhere. Even 10 years ago only two dozen archeologists directed their research toward submerged cultural resources in the United States.

> . . . archeological theory and philosophy encompass all cultural remains wherever they may be found, including material covered by water. The only difference between an underwater site and a site in any other environment is the techniques and methods required to investigate that site.[14]

Submerged and maritime resources constitute a significant part of the Nation's cultural diversity. Yet, the destruction of submerged cultural resources has intensified dramatically as a result of increased offshore drilling for oil and gas, dredging, pipeline laying, looting, and salvaging. Various water projects such as reservoir and dam building have inundated dry land and buried many other cultural resources. Until recently, however, submerged and maritime resources have been largely neglected by both government and the historic preservation community.

Technologies for Preserving Historic Structures

An important part of the historical record of the United States consists of structures (the so-called "built environment"). This workshop discussed a variety of technologies that are used for the identification, physical analysis, interpretation, and protection of historic structures. Among other things, the workshop discussion focused on preservation techniques related to cyclical maintenance of historic structures and determination of the causes and extent of materials failures.

Historic structures, which include houses, public buildings, bridges, monuments, as well as others represent to the general public the most obvious and important tangible reminders of the diversity and richness of the country's cultural heritage.[15] The U.S. historic preservation movement began over 100 years ago, when a group of private citizens, the Mount Vernon Ladies' Association of the Union, led by Anne Pamela Cunningham, recognized that the Virginia home of George Washington constituted a national historic treasure. The association worked to acquire the property when neither the State nor Federal governments would accept the responsibility of caring for it. The association still holds stewardship over Mount Vernon and has prevented encroachment on the grounds and surrounding lands by purchasing real estate, and securing easements from nearby property owners.[16]

The National Historic Preservation Act, "encourages the public and private preservation and utilization of all usable elements of the Nation's historic built environment," not only buildings that have belonged to men and women significant in U.S. history. In 1976, the first of a variety of tax incentives to encourage the rehabilitation of qualified historic structures became available, all of which have been highly effective in promoting the goal of preserving historic structures.[17]

Because the number of both privately and publicly owned structures actually designated as historic and listed on the National Register of Historic Places individually or as elements of listed historic districts is ever increasing, the scope of the technical problems associated with restoring and rehabilitating them becomes ever more challenging. In the absence of regular maintenance, which is ultimately the best and most economic approach to saving historic structures, only a limited range of often expensive treatments and singular skills are available. New conservation techniques and products must undergo careful testing and evaluation before being applied.

---

[14] "Introduction" *Underwater Archeology in the National Park Service*, Daniel Lenihan (ed.) (Santa Fe, NM: Division of Archeology, Southwest Region, 1974), p. 1.

[15] "A structure is a work made up of interdependent and interrelated parts in a definite pattern of organization. Generally constructed by man, it is often an engineering project." *How To Apply the National Register Criteria for Evaluation* (Washington, DC: National Park Service, U.S. Department of the Interior, June 1982).

[16] Albert Rains, Chairman, and Laurence G. Henderson, Director, *With Heritage So Rich* (A Report of a Special Committee on Historic Preservation Under the Auspices of the United States Conference of Mayors With a Grant From the Ford Foundation) (New York: Random House, 1966).

[17] See U.S. Congress, General Accounting Office, Fact Sheet for the Chairman, Subcommittee on Public Lands, Committee on Interior and Insular Affairs, House of Representatives, Tax Policy and Administration, Historic Preservation Tax Incentives, August 1986.

Table 4 represents areas of significance and activity used by the National Register of Historic Places. These areas of significance reflect a range of historical contexts within which the Nation's development can be understood and the historical value of prehistoric sites, structures, and landscapes can be established.

Technologies for Preserving Planned Landscapes and Other Outdoor Sites

Landscapes, whether in the form of highly structured designed landscapes such as parks and gardens, or less well-defined "cultural landscapes," such as historic farms or prehistoric shaped earthworks,[18] are an important part of U.S. cultural heritage. In order to focus attention on the technologies for preserving landscapes, this workshop primarily examined technologies associated with the preservation of planned landscapes. However, it also discussed technologies for the preservation of cultural landscapes and rock art sites.

Table 4.—Areas of Significance and Activity Represented by Historic Structures

- agriculture
- archeology
- architecture
- art
- commerce
- communications
- community planning and development
- economics
- education
- engineering/technology
- entertainment/recreation
- environment
- ethnic heritage
- exploration/settlement
- health/medicine
- industry
- invention
- landscape architecure/ horticulture
- law
- literature
- military
- performing arts/theater
- philosophy
- politics/government
- religion
- science
- social history
- transportation

SOURCE: U.S. Department of Interior, National Park Service, "How To Apply the National Register Criteria for Evaluation," Washington, DC, 1984.

The landscape preservation effort is relatively new.[19] The historic preservation movement has established and refined methodologies for preserving structures and archaeological sites over the past 50 years and has only recently begun to turn its full attention to landscapes.[20] The term "landscape" does not even appear in the categories of sites that are eligible for nomination to the National Register of Historic Places.[21]

Landscapes have a profound effect on our lives. Throughout human history, societies have both affected and been affected by their physical surroundings.[22] The result of such interactions is a landscape. Although different landscapes exhibit distinct characteristics, because landscapes may lack clear boundaries and include structures and sites as well as natural components, landscape values may be elusive, making precise and standard definitions difficult to achieve in practice.[23]

Establishing a progression of landscape types based on the scale of intentional human intervention can assist in developing common definitions. At one end of such a scale is the *wilderness,* where natural processes predominate. In a wilderness landscape, human activities certainly exist, but they do not appreciably modify the landscape.[24] We might call the next stage in the progression settlement patterns, as human manipulation of the earth becomes more obvious but there is no conscious planning. As humans manipulate the land for particular purposes reflective of their cultural values, such settlement patterns merge into *cultural landscapes*. Characteristically, the cultural landscape is the product of many groups or individuals working interdependently within a broad cultural context. Finally, the *designed or planned landscape,*[25] in which the scale of manipulation of the earth is high, is a subset of the cultural landscape that reflects the conceptual model of a single individual or small group of individuals. All of these landscape types, whether wilderness landscapes, cultural landscapes, or designed landscapes, mirror values of the peoples who live within them.

---

[18] For example, see the overview of prehistoric earthworks presented in William N. Morgan, *Prehistoric Architecture in the Eastern United States* (Cambridge, MA: MIT Press, 1980).

[19] See the discussion in W.H. Tishler, "The Landscape: An Emerging Historic Preservation Resource," *The Association for Preservation Technology Bulletin* 11, No. 4, 1979, pp. 9-26.

[20] See UNESCO, "Recommendation Concerning the Safeguarding of the Beauty and Character of Landscapes and Sites." Adopted by the General Conference at its 12th session, Paris, Dec. 11, 1962, for a relatively early attempt to define landscape preservation values.

[21] See J. Timothy Keller and Genevieve P. Keller, "How To Evaluate and Nominate Designed Historic Landscapes," *National Register of Historic Places Bulletin* 18 (Washington, DC: National Park Service, U.S. Department of the Interior, in draft), for a discussion of types of designed landscapes.

[22] See the discussion in Hiroshi Daifuku, "Introduction," *The Man-Made Landscape* (Switzerland: UNESCO, 1977).

[23] Part of the difficulty in defining the term is illustrated in the following: In general parlance, we use landscape in the broadest sense to mean environment (including both natural forms and those achieved by art). However, landscapes are often considered simply the ambiance of buildings, as when we speak of "landscaping a building." In that sense, landscapes then become equivalent to nature, in spite of the fact that in order to achieve such a landscape, the natural forms must be molded to a plan. For example, in the eyes of some observers, President Jefferson's home, Monticello, is a landscape of which the central building is the most important part. Others consider only the form and structure of the house and ignore its ambiance.

Technologies for the Physical Protection of Prehistoric and Historic Sites

This workshop identified the various human and natural threats to cultural resources and discussed a range of technologies that could be used to mitigate or eliminate them. A major component of this workshop dealt with the educational programs and technologies for alerting the public to those threats and to the importance of historic preservation. The workshop also explored impediments to effective utilization of technologies for assuring the physical security of structures, sites, and landscapes. Technologies related to the following categories were considered:

- problem identification and analysis,
- stress or threat evaluation and resolution,
- public education and interpretation, and
- data treatment and archives.

Following each workshop, OTA staff summarized the discussion, expanding, where possible, on the points offered by participants. These were then reviewed by workshop participants as well as by others in the preservation community. The final workshop reports became the basis for the chapters that make up this report.

COMMON PRESERVATION ISSUES

During the first four workshops OTA concluded that many of the issues raised are common to historic preservation as a whole. The concluding fifth workshop on protection enlarged on these common issues. This section presents and analyzes such common issues.

Cultural resources are unique, nonrenewable resources subject to continual stress from human and natural agents. The recognition of the need to limit such stresses and manage the cultural resources base, within the context of other competing uses for the land, has led to the development of a body of knowledge, practices, and techniques called cultural resources management (CRM).[26] CRM is the process of preserving our cultural heritage (sites, structures, artifacts, records, landscapes) for the benefit of the American people through the application of management skills within the political process.[27] It "is the primary context within which most professional or avocational archaeologists [and other preservation professionals] address the public nature of the resources and their treatment."[28]

---

[24] In most cases, it is not correct to talk about an untouched natural landscape. Even hunter/gatherer societies may have deliberately burned the grasses, and otherwise altered the landscape over time. For example, see Clive Gamble, "The Artificial Wilderness," *New Scientist*, Apr. 10, 1986, pp. 50-54.

[25] Because designed landscapes are generally thought of as deriving from a high art tradition, certain historical vernacular landscapes might be overlooked or considered of less historical importance than, for example, formal gardens. However, folk traditions are design traditions that involve master builders and sophisticated learning and wisdom. It is therefore extremely difficult to separate vernacular landscapes from design intention and from planning.

[26] See, William D. Lipe, "Value and Meaning in Cultural Resources," *Approaches to the Archaeological Heritage*, Henry Cleere (ed.) (Cambridge: Cambridge University Press, 1984), pp. 1-11, for an exposition of the relationship of historic cultural resources to human values.

[27] L.E. Wildesen, "Cultural Resource Management: A Personal View," *Practicing Anthropology* 2(2), 1980, p. 10. For a general discussion of cultural resources management, see Don D. Fowler, "Cultural Resources Management," *Advances in Archaeological Method and Theory* 5 (New York: Academic Press, 1982).

[28] Ruthann Knudson, "Contemporary Cultural Resource Management," *American Archaeology Past and Future*, D. Meltzer, D. Fowler, and J. Sabloff (eds.) (Washington, DC: Smithsonian Press, 1986), p. 395.

Prehistoric and historic preservation (and therefore CRM) rely increasingly on the application of a wide variety of technologies, many of which are discussed in chapters 3 through 6. Technologies can extend the scope of our understanding and care of U.S. cultural heritage by improving the quality, quantity, type, and usefulness of data gathered. They can also improve the authenticity of restoration, and the long term effectiveness of conservation and maintenance.

The boundaries between the practice of archaeology and the preservation of historic structures and landscapes are becoming increasingly less distinct. Professionals in all these disciplines apply many of the same technologies to the study and conservation of sites, structures, and landscapes. They should be aware of the assistance each discipline can give to another. For example, it is impossible for the landscape architect to reconstruct and rehabilitate with accuracy an 18th century formal garden without the professional assistance of archaeologists.[29] Architects can help archaeologists to understand some of the choices prehistoric peoples made in the construction of houses and sacred buildings.[30]

A wide array of techniques and associated equipment already exists for the discovery, analysis, and conservation of cultural resources. A core of experienced professionals is also available. Yet a variety of educational, institutional, managerial, and cost barriers inhibit the introduction of new methods, techniques, and equipment. **Preservationists in all preservation disciplines share problems of obtaining access to information about technologies, training, and coordination of research on technologies.** They also share the constraints of inadequate and decreasing funding and lack of coordinated implementation of Federal policy.

The following common issues identify and describe some of these barriers. OTA did not attempt to list the issues in priority order.

ISSUE 1:

Too few preservation practitioners and managers who contract with them have sufficient experience with advanced technologies.

This stems from a variety of causes, principal among which are the difficulty in obtaining reliable and accurate information about new techniques, the lack of educational programs to train preservation practitioners in their use, and their great expense. The complexity of some advanced technologies means that most practitioners must depend on the work of trained specialists.

For example, no project to restore a major historic structure can proceed without the involvement and interaction of individuals from several disciplines—architects, historians, structural engineers, and perhaps, chemists. No one individual can acquire the necessary expertise to tackle every task. Yet the project manager must be knowledgeable enough about the techniques, methods, and equipment used to make informed decisions about their use. Acquiring such expertise requires additional training and accessible sources of information. It is important for preservation professionals to keep abreast of the range of increasingly more sophisticated technologies, and who is using them.

Archaeologists and landscape architects share similar problems obtaining and assimilating information on new technologies. In underwater archaeology, the extremely high costs of acquiring and using appropriate new technologies have severely limited the opportunities for their use in the field. Training opportunities are therefore limited as well.

Assimilating information on new technologies requires appropriate education and training. New technical information becomes available almost constantly from science and industry. Yet, too few preservationists have even minimal training in natural science and engineering. Few training programs or courses apparently offer either information or hands-on experience with technologies. Nevertheless, archaeologists, and historians who specialize in the study of tangible cultural resources and are charged with studying and interpreting a site, structure, or landscape should have a general knowledge of the technologies, and their capabilities and limitations.

---

[29] Paul Brace, "Archeological Resources and Land Development: A Guide To Assess Impact," *Landscape Architecture Technical Information* Series 5, No. 1, September 1984.

[30] See Ralph Knowles, *Energy and Form* (Cambridge, MA: MIT Press, 1974), which discusses energy-related design choices prehistoric peoples have made, as revealed in the remains of their buildings.

ISSUE 2:

Few standards exist for the use of some new preservation techniques.

This is unavoidable in the research and testing stages of a new technique or instrument. Once it becomes part of the repertoire, standards should be developed and promulgated. Even those preservationists who are experienced in the applications of new technologies have experienced difficulty tracking the rapid growth and proliferation of some advanced techniques and methods. Because there exists no national, central clearinghouse for critically evaluating historic preservation technical information, and no institution, or group of institutions, specifically charged with charting and sponsoring the research, development, testing, and use of advanced technologies, standards have often not been set.

At present, because few standards exist for new archaeological field methods, in some cases, research funds are not well used. In the preservation of historic structures, the lack of adequate standards has led to occasional unfortunate experiences with some "high-tech" solutions to the problems of restoring, rehabilitating, and maintaining such structures (see *Chapter 4: Restoration, Conservation, Maintenance, and Protection* for examples). Many of these approaches, developed to serve other fields, have proved ineffective and unsuitable for conservation. Until the results of applications made in the laboratory and the field are assessed and available, many preservationists will for the most part remain wary of new techniques.

In cases where the volume of product sales is potentially large, for example, with techniques for stabilizing and extending the life of wood, stone, or other structural materials in wide use throughout the United States, the marketplace may serve to dictate the need for standards. Nevertheless, even with growing private sector interest, the preservation field would benefit from an organization that would provide leadership for the development of standards, and stimulate research into the behavior of new products or the benefits and drawbacks of new techniques. Such an organization would be most useful where the overall market tends to be small, as with many archaeological techniques.

ISSUE 3:

There is a strong need for better coordination in the use of new technologies for preservation.

As noted, the basic analytical tools and a core of professionals are available. However, there is no existing permanent organization of national or regional scope with the knowledge and resources required to assemble a network of collaborators and consultants prepared to tackle specific scientific problems associated with preservation. Much of what is being accomplished is ad hoc or piecemeal, often in the universities. Although some preservation work is of excellent quality, there is a lack of overall direction by Federal and State agencies, as well as a lack of communication among research specialists and agency planners and managers.

Because prehistoric and historic preservation involves many different disciplines and many different agencies at all levels of government, coordination of preservation activities is often difficult. The agencies with primary responsibility for leading preservation efforts have considerable independence and relatively few incentives for coordinating their activities directed toward developing new technologies or funding their use. Even regional offices within the agencies have great autonomy. Because agency staffs tend to be small and underfunded, they have little incentive to increase their workload by coordinating with other offices, as they view such initiatives as difficult and time-consuming. Although such autonomy does allow regional offices to tailor programs to meet their own needs, lack of adequate coordination and information transfer can result in lost opportunities to apply new and more efficient techniques. Some agencies have greater access to advanced technology and information than others.[31]

---

[31] For example, the Army historic preservation office has access to highly capable mapping systems, not generally available in other agencies.

Better coordination among Federal and State agencies would result in more effective technology transfer and application of technology. The Federal grant awarding mechanism for supporting state historic preservation programs could be used to further and enhance such coordination.

ISSUE 4:

New techniques are slow to become part of preservation research planning and research design.

New technologies, many of which provide new categories of information,[32] must be fully integrated into the data-gathering process. Difficulties of integration result in part from lack of training, but also from the rapid changes that take place in some new technologies. For example, the rapid changes in remote sensing technologies, driven by the technology's potential for mineral exploration, forestry, and agriculture, are outstripping the ability of most preservationists to keep up.

ISSUE 5:

The application of older, well-understood technologies is often inadequate.

Although certain new technologies may lead to advantages for preservation, too much emphasis on their use may divert effort from more effective use of traditional methods and tools. For example, a variety of efficient, simplified techniques are available for organizing and storing moderate amounts of records. Yet, regional Federal agency offices often maintain incomplete, disorganized and unprotected document collections and inadequate archaeological site files, use poor methods for curating collections, have not adequately identified cultural resources, and do not provide adequate protection for known sites, even with more traditional methods.

ISSUE 6:

Many traditional preservation methods will continue to be useful, effective, and economical.

Participants in each of the OTA workshops emphasized that certain traditional technologies for preserving historic structures will continue to be useful, effective, and economical. For example, periodic or cyclical maintenance still provides the best line of defense against many kinds of threats.

In general, the more advanced, and often more expensive, technologies are of high utility for the discovery and documentation phases of preservation. These include nonintrusive and nondestructive methods such as remote sensing, and infrared and X-ray analysis. Traditional technologies, including some truly historic methods, tend to be more applicable to the restoration and conservation phases of the preservation process.

ISSUE 7:

In certain areas, technologies used by other countries may represent significant advances over U.S. practices.

Many other countries, particularly those of Europe, have long engaged in historic preservation coordinated through ministries of culture, which, whether regionally or nationally focused, have supported the research, development, and use of appropriate techniques for preserving prehistoric and historic sites, structures, and landscapes. Preservation efforts among the industrialized nations, through such organizations as the United Nations Educational, Scientific, and Cultural Organization (UNESCO), International Council on Monuments and Sites (ICOMOS), and International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) have accelerated dramatically in response to growing environmental threats. Some of these efforts have resulted in the development of techniques, methods, and equipment that are more advanced than U.S. technologies.

For example, archaeologists in the United Kingdom and some European countries have generally been highly innovative in developing advanced technologies. The universities also offer an archaeological curriculum that includes training in the natural sciences.[33] In part, this is the result of the fact that in Europe, archaeology is not necessarily thought of as a subdiscipline of anthropology, as it is in the United States, but as a science and art in its own right. The Europeans have used remote sensing methods, including aerial photography and photogrammetry, since the early decades of this century.[34] In addition, the application of magnetometry and electrical resistivity to ground survey began earlier in Europe. Even some developing countries, such as Indonesia, Peru, and Turkey, which lack the financial resources for extensive preservation of their cultural heritage, have made widespread use of photogrammetry for documenting their public buildings.

---

[32] For example, in archaeology, the information on ancient climate provided by analysis of stable carbon isotopes in wood, instead of the older, well-established technique of analyzing fossil pollens, or data on celestial alignments provided by archaeoastronomy.

Two outstanding underwater archaeological and maritime conservation efforts in Sweden and England are providing models for the Monitor preservation project in the United States. These two efforts illustrate the level of commitment, time, energy, expertise, and funding that are necessary in first-rate conservation of submerged cultural resources. The Wasa is a well-preserved Swedish warship built in 1628 and recovered virtually intact from Stockholm Harbor in 1961. It was the first such recovery of its type and size ever realized and has proved the model for subsequent ship recovery projects. Most of the advances in technology for the long-term conservation of submerged materials were achieved during its rescue.[35] The Mary Rose, a Tudor warship built in 1545, was recovered in 1982 near Portsmouth, England. The effort that went into its preservation represents an excellent model of interdisciplinary research and project management.

West German methods of recording historic structures (so-called measured drawings) are far more complete and result in more accurate and detailed drawings than U.S. methods. European countries have also made extensive use of stereo photogrammetry to make high-quality drawings of buildings, monuments, and historic landscapes. They also use photogrammetry to monitor secular changes in buildings and landscapes.

The European preservation community has been very active in using various forms of remote sensing for studying landscapes. For example, the city of Amsterdam used an airborne infrared camera to detect ailing trees in historic parks. Many stresses to plants, trees, and shrubs are apparent in the infrared before they appear at visible wavelengths. In the United States, such techniques have been used to detect crop stress in corn and other agricultural commodities.

Foreign experiences with preservation techniques, methods, and equipment should be examined closely for possible transfer to U.S. applications. The United States would also benefit by increased cooperation with other nations in developing and testing new preservation methods.

---

[33] For example, the University of Bradford in England.

[34] However, within the United States, recent advances, stemming in part from the advent of remote sensing from space (in 1972) and the development of the associated computer software have enhanced the U.S. application of such data for archaeology.

[35] *The MONITOR National Marine Sanctuary in Perspective*, Dr. Nancy Foster, Chief, Sanctuary Programs Division, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration.

A CENTRALIZED CONSERVATION FACILITY

The previous discussion led all five workshops to conclude that a new institution (or expansion of an existing institution's mandate) or center is needed that would foster the research and development of advanced technologies, the training of professionals in their use, and the dissemination of accurate technical information. Several museums maintain first-rate analytical facilities for conserving artifacts, but no comparable facility exists for conserving sites, structures, and landscapes.

Chapters 3 through 6 discuss numerous preservation problems that such a center might work on. As discussed in more detail in the concluding chapter, most workshop participants agreed that a center for preservation technology should be federally supported, primarily because of the large stake the Federal Government has in fostering and guiding excellence in preservation.

ORGANIZATION OF THE REPORT

During the workshops, and especially in preparing the draft workshop reports, it became clear that the boundaries between each broad subject area are becoming increasingly indistinct. Those who seek to preserve prehistoric and historic sites, structures, and landscapes share many problems in obtaining access to information about technologies, training, and coordination of research in new techniques. In addition, they share most of the same technologies. Finally, they all experience the constraints of ever more limited funding and lack of coordinated Federal policy and implementation. Hence, it seemed appropriate to organize this report, which focuses on preservation technologies, around the issues raised by the technologies themselves, and how they are applied in the various stages of the research and preservation process, rather than force discussion of these issues into a disciplinary mode.

The Chapters

Chapter 3: Research explores issues concerning technologies utilized in discovering, recording, and analyzing sites, structures, and landscapes. Many of the most dramatic recent advances in applying technologies to preservation, such as remote sensing, geographic information systems, and predictive modeling, have been made during the discovery stage of the research process.

Chapter 4: Restoration, Conservation, Maintenance, and Protection explores the many techniques, methods, and equipment required for conserving and protecting cultural resources for future research, interpretation, and public enjoyment. The primary concern expressed by the many contributors to this study is the rapidity with which historic structures and landscapes, as well as archaeological sites, are being destroyed as a result of land development, vandalism, looting, erosion, and other human and natural causes. This chapter discusses the cultural resources management and law enforcement issues related to such losses, and presents several advantages and limitations of technology in mitigating them.

Computers are only beginning to affect profoundly the conduct of prehistoric and historic preservation. *Chapter 5: Preservation Information* examines the part computers and other technologies for storage and retrieval of data and information play in preservation.

Educating the public, who provide most of the funding for prehistoric and historic preservation, on the results of preservation research and treatments, is a crucial component of prehistoric and historic preservation. *Chapter 6: Public Education* addresses the role technologies play in public education, and making such learning enjoyable as well as meaningful.

The Federal Government provides much of the leadership for historic preservation. *Chapter 7: Technology and Preservation Policy* examines the issues raised in the previous chapters and discusses options for improving the implemention of current Federal preservation policy. It also suggests and analyzes new policy avenues Congress might wish to explore. Finally, it discusses State, local, and private sector contributions to preservation.

OTA selected a review panel, composed of participants from each workshop, to review the final draft of the report. In addition, the draft was sent to a variety of others, both within and outside of government, who reviewed selected portions.

OTA is grateful to the workshop participants and to the many others from Federal, State, and local agencies, the universities, private firms, and organizations who provided information or reviewed portions of this report in draft. Their helpful and timely comments and suggestions are an important part of this report.

Chapter 3

Research

Contents

Page

Introduction 43

Technologies for Discovery 43
  Archival Research and Oral Histories 43
  Remote Sensing (Space, Aerial, and Geophysical Methods) 44
  Predictive Modeling 54
  Identification and Survey of Submerged Cultural Resources 56

Documentation and Analysis 59
  Technologies 60

Issues 70
  Archaeology 70
  Underwater Archaeology 72
  Historic Structures 72
  Landscapes 74

List of Tables

Table No. *Page*

5. Representative Technologies for Identification and Survey 44
6. Remote Sensing Instruments 45
7. Technologies for Gathering and Analyzing Data 60
8. Technologies for Analyzing the Physical Condition of Wood 63
9. Technologies for Analyzing the Physical Condition of Masonry 64
10. Technologies for Analyzing the Physical Condition of Reinforced Concrete 65
11. Technologies for Analyzing the Physical Condition of Iron and Steel 66
12. Dating Prehistoric Sites 67
13. Major Equipment of the National Bureau of Standards' Center for Building Technology 74

List of Figures

Figure No. *Page*

1. Diagram of the Electromagnetic Spectrum 46
2. Categories of Historic Landscapes 75

Chapter 3
Research

INTRODUCTION

Historical and scientific research, interpretation to the public, and preserving U.S. cultural heritage for future generations are the primary purposes for preserving sites, structures, and landscapes. New technologies can improve the quality and quantity of research data gathered. They may also make possible the investigation of lines of evidence that were previously impossible. This chapter presents many of the technologies used for preservation research and discusses the issues they raise. For the purposes of analysis, OTA divided preservation research into the following steps, which do not necessarily represent an unfailing progression:

- discovery (survey, identification);
- documentation (mapping, physical investigations, recording); and
- analysis (evaluation).

Although for the purposes of analysis and discussion it is possible to separate these research steps, in practice, they are tightly interconnected. In order to construct a research plan for a project, it is necessary to decide prior to conducting fieldwork which technologies are to be used. The choices of technologies in turn depend on the research hypotheses the investigator wishes to explore, and on the results of preliminary archival research. In addition, many of the technologies employed for discovery are also useful or even essential for the documentation phase of research. It is therefore impossible completely to separate the discussion of the technologies for different phases.

The following discussion attempts to examine technologies in the research phase in which they are most often applied. The enumeration is far from comprehensive; rather the technologies have been chosen to illustrate the role of technology in preservation and are therefore representative of a much larger available array.

The research objectives of archaeology and the study of structures or landscapes are frequently very similar. Architectural historians and landscape architects often depend on archaeological research in analyzing historic structures or landscapes.[1] Archaeology, by the same token, uses historical research. This chapter focuses on the various technologies used by all preservation disciplines. Where necessary, the specific concerns of each discipline are discussed independently.

---

[1] See, for example, Paul Brace, "Archeological Resources and Land Development: A Guide to Assess Impact," *Landscape Architecture Technical Information Series* 5, No. 1, September 1984.

TECHNOLOGIES FOR DISCOVERY

The first step in gathering data is to locate cultural resources on the ground, under the ground, and under water. This section discusses several technologies (table 5) that are used primarily for identification and survey. Some, such as the remote sensing technologies, are often applied to the data-gathering phase of research or evaluation and assessment as well.

Archival Research and Oral Histories

Archival research and interviewing (oral history) are important first steps in the research process. Preliminary research, done with care and imagination, can save time and money as well as provide a focus for technological field work and a broad basis for the establishment of significance.

Table 5.—Representative Technologies for Identification and Survey

Technical areas	Technologies
Remote sensing:	
Air	lidar, photography, radar
Space	radar, multispectral sensors
Geobased	magnetic detection, radar, seismic, thermography, X-ray, infrared, gamma-ray inspection
Marine	side-scan sonar, magnetometer, sub-bottom profiler, precision fathometer, electronic position finder, remotely operated vehicles
Terrestrial imaging	photography video photogrammetry
Computer technology and applications	theoretical modeling and prediction acquisition and interpretation of archival data management and dissemination of archival data mapping geographic information systems computer display
Social science techniques	oral history and folklore: tape recording photography video archival documentary research

SOURCE: Office of Technology Assessment.

Developments in archival technology of various sorts can make the records search more efficient and even more cost-effective than it is now (see *Chapter 5: Preservation Information*).

The technical questions involved with this type of historical research specifically concern methods of access to information in the institutions which house it, and ways of arranging data to make it usable for preliminary analysis and development of a research plan. Interviewing depends on the technologies for tape recording and archiving electronic storage media if oral history materials are to be retained.

Remote Sensing (Space, Aerial, and Geophysical Methods)

Remote sensing, as with most other technologies used in preservation, originated in other fields and is being adapted and molded to fit preservation requirements. The detail provided in this section illustrates the roles played by the natural sciences and engineering in providing technologies useful for preservation. Other technology discussions provide much less detail.

Remote sensing[2] from aircraft and from space, and other types of remote sensing techniques (table 6), such as ground-penetrating radar, hold great promise for the future of archaeology and the study of historic landscapes, because they are nondestructive and capable of analyzing vast areas quickly and accurately. Such techniques are less useful in the identification and survey of historic structures. Photogrammetry, which can be thought of as another form of remote sensing, has found greater utility for surveying historic structures, and is also used for archaeology and historic landscapes (discussed below).

Remote sensing technologies can aid substantially in recording accurately the positions of archaeological sites, and analyzing them within an environmental context.[3] They can also help in evaluating sites. They are useful both in predictive location modeling, and in onsite exploration in lieu of extensive testing. Remote sensing techniques employing aircraft and spacecraft have also been applied to the study of prehistoric and historic landscapes.[4]

Remote Sensing From Aircraft and Spacecraft

Intrigued by the special perspective that balloons gave them, photographers began experimenting with aerial photography in the last cen-

---

[2] In general terms, remote sensing is the art of obtaining information about objects, areas, or phenomena through analyzing data gathered by devices placed at a distance from the subjects of study. Remote sensing may refer to sensing over short distances, as in medical or laboratory research applications using lasers, or over long distances as in environmental monitoring from spacecraft using advanced electro-optical instruments. Once the initial data are sensed, they must be analyzed and interpreted either visually or through sophisicated computer analysis.

[3] See, for example, *Remote Sensing: A Handbook for Archaeologists and Cultural Resource Managers, Contribution No. 4* of the Chaco Center, National Park Service and University of New Mexico, 1977. Also, Thomas R. Lyons and James I. Ebert (eds.), "Remote Sensing and Nondestructive Archeology," National Park Service Remote Sensing Division, 1978.

[4] Carole L. Crumley, "Archaeological Reconnaissance at Mont Dardon, France," *Archaeology*, May-June 1983, pp. 14-17, 20; and Scott L.H. Madry, "Remote Sensing in Archaeology," *Archaeology*, May-June 1983, pp. 18-19.

Table 6.—Remote Sensing Instruments[a]

Type of Instrument	Comments
Spacecraft:	
Multispectral scanner . .	U.S. Landsat (resolution 80 meters; 3 spectral bands)
Thematic Mapper	U.S. Landsat (resolution 30 meters; 7 spectral bands)
Shuttle Imaging Radar[b]	Carried on Shuttle
SPOT	French SPOT (resolution 20 meters in 3 spectral bands; 10 meters in B&W)
Aircraft:	
Photographic camera	
Multispectral scanner	
Thermal infrared mapper	
Geophysical techniques:	
Proton magnetometer	
Soil conductivity meter	
Soil resistivity meter	
Ground-penetrating radar	
Metal detectors	
Terrestrial photogrammetry:	
Precision camera	
Stereo comparator	
Stereo analog plotter	Needs precision cameras
Stereo analytical plotter	Uses digital techniques and a computer

[a] See Robert Colwell, editor-in-chief, *Manual of Remote Sensing* (Falls Church, VA: American Society of Photogrammetry, 1983).

[b] Charles Elachi, JoBea Cimino, and M. Settle, "Overview of the Shuttle Imaging Radar-B Preliminary Results," *Science* 232 (1986), pp. 1511-1516.

SOURCE: Office of Technology Assessment.

tury. They continued their experimentation from aircraft soon after the first airplane was flown. Aerial photography has since become an important part of soil conservation, flood control, highway design, city and county planning; and, of course, military reconnaissance. The National Archives and Records Administration, and the Agricultural Stabilization and Conservation Service of the Department of Agriculture, maintain extensive collections of aerial photographs of the United States. USDA field offices may hold the most current photos for their localities.

The scientific and applications-oriented communities recognized the potential value of sensing the Earth's surface from space early in the development of the Nation's space program. Space remote sensing was an obvious extension of remote sensing from balloons and aircraft. However, the expense of returning film from space,[5] the need to manipulate data in a computer, and the desire to sense Earth in a variety of wavelengths led to the development of electronic multispectral scanners that operate in a variety of colors, or spectral bands (figure 1). The United States launched its first land remote sensing satellite in 1972, which carried an experimental multispectral scanner. Landsat 5, the fifth in the series of civilian land remote sensing satellite, is now providing high-quality images of Earth on a regular basis.[6] The resulting electronic signals are transmitted to Earth where they are converted into data susceptible to computer manipulation.

For purposes of preservation, the ability of remotely sensed data from space to resolve objects the size of individual sites or structures has been highly limited in the past.[7] However, the SPOT system recently deployed by the French achieves ground resolutions of 20 meters (65.6 ft.) in three spectral bands, and 10 meters (32.8 ft.) in black and white. Data of such relatively high spatial resolution, when processed with other data, such as those relating to soils and color, will be highly effective in providing information concerning preservation. Recent developments in computer image analysis can improve on the resolution of such images by at least a factor of 2.[8]

Of more importance to archaeology, because of their better ground resolution and ability to sense in many spectral bands, are multispectral scanners for aircraft. Originally developed as part of the testing program for the Landsat satellites, they have proved extremely successful in aircraft applications.[9] With them, surface resolutions of a few feet can be achieved in many different spec-

---

[5] The early reconnaissance satellites discharged canisters of film, which were then caught by specially equipped aircraft. Such methods are now being explored for possible civilian use for special projects, such as crop or forest inspection, requiring high resolution and quick return of data.

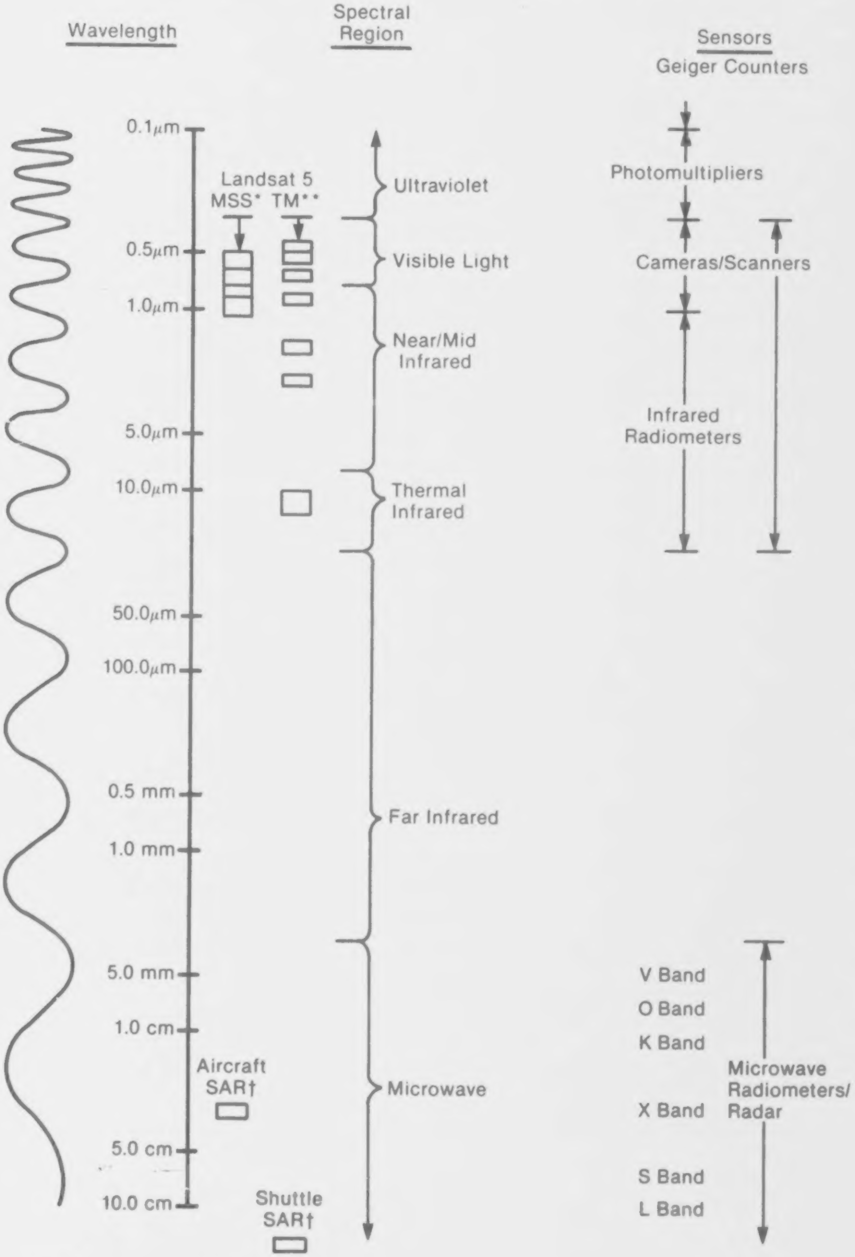
[6] See U.S. Congress, Office of Technology Assessment, *Remote Sensing and the Private Sector: Issues for Discussion,* OTA-TM-ISC-20 (Washington, DC: U.S. Government Printing Office, March 1984), for a discussion of some of the many uses of remotely sensed data. See also U.S. Congress, Office of Technology Assessment, *International Cooperation and Competititon in Civilian Space Activities,* OTA-ISC-239 (Washington, DC: U.S. Government Printing Office, July 1985), ch. 7.

[7] For example, the multispectral scanner on the U.S. Landsat has a resolution limit of 80 meters, and the Thematic Mapper a resolution limit of 30 meters.

[8] William J. Broad, "New Power Lets Computer Depict Images Invisible to Eye," *New York Times*, Sept. 2, 1986.

[9] Thomas Sever and James Weisman, "Remote Sensing and Archaeology: Potential for the Future," National Aeronautics and Space Administration, Earth Resources Laboratory, January 1985.

Figure 1.—Diagram of the Electromagnetic Spectrum


Wavelength
Spectral Region
Sensors
Geiger Counters
0.1μm
0.5μm
1.0μm
5.0μm
10.0μm
50.0μm
100.0μm
0.5 mm
1.0 mm
5.0 mm
1.0 cm
5.0 cm
10.0 cm
Landsat 5
MSS* TM**
Aircraft SAR†
Shuttle SAR†
Ultraviolet
Visible Light
Near/Mid Infrared
Thermal Infrared
Far Infrared
Microwave
Photomultipliers
Cameras/Scanners
Infrared Radiometers
V Band
O Band
K Band
X Band
S Band
L Band
Microwave Radiometers/ Radar

*MSS: Multispectral Scanner
**TM: Thematic Mapper
†SAR: Synthetic Aperature Radar

SOURCE: National Aeronautics and Space Administration.

tral bands. High surface resolution is important in examining details of a site. The different spectral bands are extremely helpful in locating sites according to vegetation differences that appear near human habitations.

To make effective use of archaeological remote sensing, one needs first to understand the general features of the region's archaeology. It is then possible to incorporate remote sensing into a research scheme, keeping in mind the limitations as well as the advantages of the technology. For example, in many cases it is not even possible to detect the archaeological sites directly on remotely sensed data. Sites may consist of small piles of stone, or pottery, or may be lost in the subsequent vegetation. Therefore, other indicators, such as vegetation, are necessary.[10]

Remote sensing is potentially useful for examining the environmental effects on a site. It can also be used effectively for investigating how well we can discover certain categories of sites. Remote sensing can also be useful for logistics—finding your way in the field, locating sample units, etc. Nevertheless, remote sensing cannot replace archival survey or traditional walking survey and more intensive archaeological activities, including excavation.

In the past, to use remotely sensed data to find sites, it was necessary to hand digitize all the available surface information into a Geographical Information System (see Documentation and Analysis section for a discussion of this technique), then put known sites on the map, and look for commonalities in the surface features that would indicate new sites. By putting layers of information together, it is possible to extract general rules for the likelihood of finding unknown sites.[11] Such a method will not find sites, but it does help predict where they are more likely to be. Now this can be done automatically.

In a related development, optical engineers have developed a relatively inexpensive optical digitizer. Among other things, such devices have helped to analyze handwriting and to translate handwritten material to printed form from 19th century ledgers kept by agents of the Bureau of Indian Affairs, for example (see *Chapter 5: Preservation Information*). For archaeology, similar techniques can be applied, for example, to hieroglyphs on damaged Mayan carvings, allowing experts in Mayan writing to interpret details of the signs invisible to the naked eye.[12]

Although archaeologists find remote sensing techniques extremely useful in locating individual sites, and exploring patterns of human settlement, they can also use such techniques to choose the best sites for later excavation. However, the methods of distinguishing among a group of suitable sites are still under development and need to be refined before remote sensing can be fully applied to this process.

Remote sensing technologies that hold the greatest future promise for improving site and landscape discovery, identification, and evaluation are those that provide a broad, overall (synoptic) view and record data in digital form for direct computer processing (e.g., multispectral scanners on spacecraft or aircraft). However, for most applications today, aerial photographs are extremely valuable and much cheaper than multispectral scanners. They can also be used for identifying and assisting in determining the significance of historic structures.

Research Needs

- *More effective use of aerial photography:* Photography is still the most useful and inexpensive data source with the highest resolution, both spatial and temporal. Yet in some regions we do not always understand at what time of year and under what conditions (e.g., in terms of the growing cycles of plants) to use infrared photography for best results in archaeology.[13] Recently developed

---

[10] This was demonstrated recently in an effort to find Mayan cities in the Yucatan peninsula using data acquired by the Landsat Thematic Mapper. Ramon trees (*Brosinum alacastrum*) grow preferentially in the central plazas of ancient Mayan cities. The different color channels of the Thematic Mapper can be used to detect Ramon trees, though the instrument will not detect the plazas directly.

[11] See, for example, Jay F. Custer, et al., "Application of Landsat Data and Synoptic Remote Sensing to Predictive Models for Prehistoric Archaeological Sites: An Example From the Delaware Coastal Plain," *American Antiquity* 51, 1986, pp. 572-588.

[12] Thomas Sever, NASA, personal communication, 1985.

[13] See Thomas E. Davidson and Richard Hughes, "Aerial Photog-

(continued on next page)

digitizing methods (see below in section on photogrammetry) may make such photographs of much greater utility in archaeological research. **It will be important to conduct systematic research to determine the most effective times and ways to use aerial photographic techniques.** For example, in some investigations, it may be cost-effective to suspend a radio-controlled camera from an inflatable blimp to document and map sites, structures, or even landscapes.[14]

- *The use of historical aerial photographs for monitoring site condition through time:* Many of the older aerial photographs (from files of the U.S. Department of Agriculture's Soil Conservation Service, and in the Cartographic Branch of the National Archives and Record Administration, for example) may provide useful historical information on sites, but they have not been fully exploited. Aerial photographs have been taken of most places in the United States many times since the early 1930s, and provide a unique record of changes in the landscape and in archaeological materials on and in it since that time. Not only can the use of such photos serve to alert managers about impending changes or destruction of archaeological sites and landscapes from natural or human causes, they can also point the way to understanding a variety of natural processes that affect them. For archaeology, historic aerial photographs can assist in understanding those processes that affect all archaeological materials from the time they are deposited by their original users to when they are found by archaeologists.

Newark Earth Works, Newark, Ohio

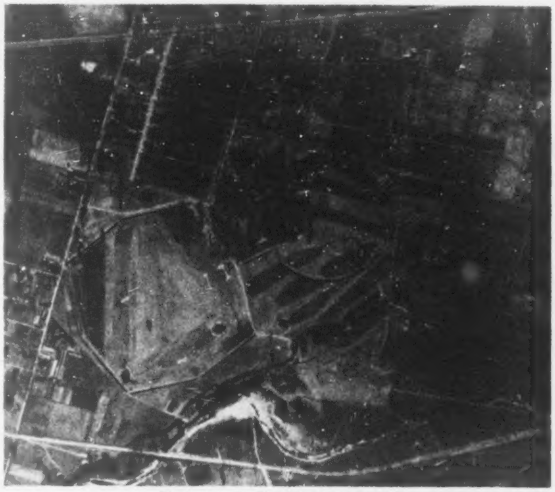


Photo credit: Photo by Dache M. Reeves, January 1984. Courtesy of Smithsonian Institution National Anthropological Archives

Historical aerial photo of earthworks planned and constructed by the Hopewell people, a culture of prehistoric mound builders. This site has been used for a golf course since the 1930s. It and a related one nearby may be astronomically aligned. The circular earthwork encloses about 20 acres and the octagon about 50 acres. Similar prehistoric earthworks in the Eastern United States often enclose areas of up to 50 acres.

For example, a current study being conducted for the Army Corps of Engineers,[15] focuses on understanding types and rates of erosion affecting large archaeological sites located on Corps of Engineers' reservoirs along the upper Missouri River. Some of the study sites are covered by as many as 26 series of aerial photographs taken at different times of the day and year and at various scales and photographic emulsions (black and white, color, color infrared) since 1933. The study will compare erosion rates calculated from the photographs with reservoir dynamics, climate, and landform to arrive at erosion projections for use in directing future erosion control at the sites. Studies such as this could be effective for erosion of historic landscapes and for erosion patterns around historic structures.

- *Continued study of the spectral bands most effective for preservation:* The spectral bands for aerial scanning spectrometers and for space systems have been chosen for their utility in minerals detection and in the management of agricultural or forestry resources.

(continued from previous page)

raphy and the Search for Chicone Indian Town," *Archaeology* 39, 1986, pp. 58, 59, 76, for a description of recent research using infrared aerial photography at different seasons to search for the remains of a Nanticoke Indian town in Delaware. One of the goals of their research was to demonstrate the effectiveness of aerial infrared techniques for use in the Middle Atlantic States.

[14] J. Wilson Myers and Eleanor Emlen Myers, "Aerial Photography at Ancient Sites," *Context* 4, Boston University Center for Archaeological Studies, 1958, pp. 1-5.

[15] For the Vicksburg Waterways Experiment Station, by Ebert & Associates, Albuquerque, NM.

The spectral bands that best display certain kinds of archaeological sites may be different from those that are best for forestry or agriculture. Determining how best to use these or other spectral bands for the special needs of preservation will require continued study.

Such considerations apply especially to the use of optical scanners. To be most efficient for preservation, the total system (scanner and associated computer software) should be designed for the specific preservation need. For example, the best mix of spectral bands and ground resolution to use in studying structures is likely to be different from the mix for agriculture or minerals exploration. Because of the different soils and vegetation, even regional differences may dictate different approaches to optical scanners. However, the use of existing systems, though not designed specifically for preservation work, may be more cost-effective, at least in the short term.

- *Problem orientation—matching preservation data needs with appropriate remote sensing technology:* As in the application of any technology, a problem must first be defined and the data needs appropriate to its solution chosen realistically. This requires a sound understanding of the limitations as well as the possibilities offered by technologies.

Many remote sensing technologies have not been explored systematically to determine their potentials and limitations for archaeology. However, they may yield unimagined new data. For example, only one systematic series of experiments in the use of optimum conditions for thermal scanning for the discovery of archaeological remains has been conducted.[16] In that set of experiments, using the French ARIES airborne thermal scanner, the experimenters flew the scanner many times over several valleys in France where Celtic field boundaries were known to exist but were not obvious either with ground survey or on conventional aerial photographs. In each overflight, they recorded cloud conditions, air temperature, and soil temperature, as well as the recent history of these quantities. Their experiments demonstrated that only during very short "windows" of a few hours every several months was thermal scanning useful for locating such features. Its application to different sorts of features would require different conditions.

Costs.—Costs for processing remotely sensed data are decreasing rapidly, so the data will be easier and cheaper to use in the near future. Until recently, users of data sensed from space (e.g., on the Landsat system) have had to rely on expensive mainframe computers to process the data. It is now possible to purchase a microcomputer system (including both hardware and software) to analyze such data for less than $25,000.[17]

Users of remotely sensed data must always weigh the costs associated with analyzing large areas against the spatial and spectral resolution desired. The greater the resolution, the more expensive the processing. Because the number of data elements per area increases by the square of the resolution, the costs of processing information increase nearly by the same rate. It is therefore important to choose the spatial resolution most appropriate for the application. For certain problems, enhanced spectral information may be more important than greater spatial resolution. For example, particular spectral bands may contain information that enables one to determine, for example, plant type, the presence of phosphates in the soil, or the presence of trapped moisture. All three signs may indicate the presence of subsurface features otherwise invisible.

Geophysical Remote Sensing

Depending on the nature and depth of burial, such instruments can find and explore buried or partially buried archaeological sites without damaging them by excavation.[18] Some of these sites occasionally include extraordinarily well-preserved sites that have been hidden from looters and occasional collectors. As many of the sites found by such methods are not threatened by looting, erosion, or other natural or human threats, such methods will become increasingly important as the more accessible sites are destroyed.

---

[16] See M.C. Perisset and A. Tabbagh, "Interpretation of Thermal Prospection on Bare Soils," *Archaeometry* 23, 1981, pp. 169-188.

[17] See the discussion on this and related topics concerning the development of lower cost processing for remotely sensed data from space in an earlier OTA report entitled *International Cooperation and Competition in Civilian Space Activities,* OTA-ISC-239 (Washington, DC: U.S. Government Printing Office, June 1985), ch. 7.

Proton Magnetometer.[19]—The proton magnetometer is used to measure extremely small changes in the local magnetic field near archaeological features caused by small differences between the magnetic characteristics of buried structural features or material and the surrounding soil.

The ability to measure such differences depends directly on the fact that protons, basic building blocks of the atom, tend to align themselves in the direction of the Earth's magnetic field. The stone or fired clay of artificial subsurface features produce magnetic anomalies in the local magnetic field that can be measured by detecting small changes in the tilt of protons as they spin in the magnetic field of the Earth. As the investigator moves the instrument across the Earth in a grid pattern, the anomalies show up as slight changes in the direction and intensity of the local magnetic field. Plotting such anomalies on a grid leads to a rough map of the subsurface features. Brick, fire hearths, and iron-bearing materials show up best in this technique, although some earthen features are also measurable.

This method can markedly improve the efficiency of locating some subsurface archaeological features by avoiding the necessity for digging test pits. Sites can be investigated at rates of 10 minutes per square meter. The method is particularly useful for shallow subsurface features. However, small, deeply buried features are extremely difficult to detect with this technique, because the alterations of the Earth's magnetic field produced by these features are small.

Soil Resistivity Meter.—Different soils exhibit different resistance to the passage of electric current, primarily as a result of their varied water content. This method involves measuring the electrical resistance of soil to the application of a small current between two electrodes inserted in the ground. Archaeological features tend to have a different water content than the surrounding soil.

Although this technique is much simpler and cheaper than radar or magnetometer methods, it is much more tedious and time-consuming because it requires placing electrodes in the Earth at each point of a grid pattern over the archaeological features under study. However, because it is simpler and can be used near buildings, power cables, surface iron, and other materials that would make the use of magnetometers impossible, it is sometimes the appropriate choice. It can therefore be used more readily in urban settings.

Soil Conductivity Meter.—This instrument is similar to the soil resistivity meter, but measures instead the conductivity of the soil, using electromagnetic techniques. In one form, developed by Geonics Ltd., of Canada, the device uses a varying magnetic field to induce currents in the ground below the instrument that are proportional to the soil's conductivity. These currents in turn generate magnetic fields that can be measured with the instrument. The major advantage of such an instrument is that it does not require probes and can therefore be used to map terrain as quickly as an operator can walk across it.[20]

Ground-Penetrating Radar.—Ground-penetrating radar instruments emit microwave pulses at frequencies that will radiate below the Earth's surface. A receiving antenna carried along the surface with the instrument on a cart or sled detects echoes from buried features or discontinuities in the soil. The time of return of the echo determines how deep the feature is. This method works particularly well for detecting buried walls, floors, and foundations. It requires sharp differences in the radar reflecting characteristics between artificial features and the earth surrounding them. Concentrations of brick and metal produce strong echoes.

---

[18] See Payson D. Sheets, "Geophysical Exploration for Ancient Maya Housing at Ceren, El Salvador," *National Geographic Society Research Report: 1979 Projects*, pp. 645-656, for a discussion of the use of geophysical exploration techniques in volcanic tephra.

[19] For descriptions of this and other geophysical techniques, see M.S. Tite, *Methods of Physical Examination in Archaeology* (London and New York: Seminar Press, 1972). See also John W. Weymouth, "Ch. 2: Archaeological Site Surveying Program at the University of Nebraska," *Society of Exploration Geophysicists Technical Program Abstracts*, Dec. 1-6, 1984, pp. 191-193.

[20] J.D. McNeill, "Electrical Conductivity of Soils and Rocks," Technical Note TN-5, Geonics Ltd., Ontario, Canada, October 1980.

Considerable experimentation may be necessary to determine which frequencies are appropriate for the particular region and sites under investigation. For example, one investigator found that in investigating two different sites in Canada, operating with antennas at a frequency of 350 megahertz provided the ability to penetrate from 1 to 3 meters depth, and a resolution of position in the ground of a few centimeters. Using antennas capable of operating at 100 megahertz would penetrate much deeper, up to depths of 30 or or 40 meters, but with resolutions no better than one-fourth of a meter. The latter instrument is therefore more appropriate for survey, the former for detailed investigations of features relatively near the surface.[21] Another investigator, working in south-central Ohio, found good results using transmission frequencies of 650 megahertz.[22]

Metal Detectors.—Electromagnetic metal detectors, of the type often used to find buried metal pipes and cables, and to detect military mines or buried bombs, can also be used in archaeological contexts where metal-bearing artifacts or features are expected. With these instruments, a changing magnetic field produced by the instrument induces small currents, called eddy currents, in buried metal objects, which can then be detected by a receiving coil connected to the instrument. The more sensitive instruments of this type can detect coins or small metal artifacts in graves. They have been successfully used to locate artifacts on historic battlefields.[23] The metal detector is an example of a technology that is also inexpensively available to relic hunters, some of whom may use them on public lands.[24] (See *Chapter 4: Restoration, Conservation, Maintenance, and Protection* for discussion of such issues.)

Proton magnetometers and other site-scale instruments, such as ground-penetrating radar, can be used to define the structure and limits of a site, and to plan excavation or sampling. For example, they have been successfully used to map otherwise nearly invisible features of prehistoric earthwork remnants in central Ohio.[25] Although the information provided by such methods cannot substitute for a detailed excavation, they may provide important information concerning where to excavate within a large structure or site. Additionally, where the form, orientation, or location of a site is the information sought, such methods are far less costly and take less time than digging test pits or trenches.

To make these methods most useful, archaeologists need to refine their understanding of which of these technologies to apply to a particular geographic area, soil type, or season. For example, the proton magnetometer is most useful where the archaeological features produce relatively strong alterations of the Earth's magnetic field. Ground-penetrating radar can often be used over frozen ground at times of the year when the probes required with soil resistivity, or soil conductivity meters cannot be inserted in the soil. In some cases, the application of several different instruments may be appropriate as the data they generate are often complementary. In addition, for these as well as many other archaeological methods, "a sound knowledge of the living processes of the historic and prehistoric inhabitants that occupied the site and the types of features that they might have created are invaluable for the design of data collection procedures and subsequent interpretation of the data."[26]

---

[21] C. J. Vaughan, "Ground-Penetrating Radar Surveys Used in Archaeological Investigations: Two Case Histories," *Society of Exploration Geophysicists Technical Program Abstracts*, Dec. 1-6, 1984, pp. 195-197.

[22] N'omi Greber, "Salvaging Clues to a Prehistoric Culture," *The Gamut*, Cleveland State University, spring/summer 1981, pp. 35-45.

[23] Stephen W. Sylvia and Michael J. O'Donnell, "Underground Warfare: Hunting for Relics on Civil War Battlefields," *Man At Arms Magazine*, July/August 1979.

[24] Recently, several men were apprehended and convicted of looting the Richmond Battlefield of Civil War relics. They used a metal detector.

[25] See N'omi Greber, "Geophysical Remote Sensing at Archaeological Sites in Ohio: A Case History," *Society of Exploration Geophysicists Technical Program Abstracts*, Dec. 1-6, 1984, pp. 185-189, for a comparison of the use of resistivity and ground-penetrating radar.

[26] Robert Huggins, "Some Design Considerations for Undertaking a Magnetic Survey for Archaeological Resources," *Society of Exploration Geophysicists Technical Program Abstracts*, Dec. 1-6, 1984, pp. 210-212.

Several lost historic towns in Mississippi were also located in a similar way. When the towns were inhabited, people planted crepe myrtle and osage orange around their homes. Though all visible signs of dwellings have since disappeared, the trees still exist and because of how they show up in the different spectral bands imaged by the Thematic Mapper, they can be detected and separated from the other vegetation.[27]

Terrestrial Photography and Photogrammetry

Although terrestrial photography and photogrammetry are closely related to remote sensing, they are generally applied over much smaller areas and at closer ranges than aerial and space or geophysical methods. Such methods include stereo photogrammetry as well as conventional photographic recording of structures[28] and landscapes, archaeological sites, and rock art sites.

Traditional Stereophotogrammetric Methods (Photo-theodolite).—Traditional methods have made use of a pair of large (9x9 inch) or medium format (4x5 inch or 2¼ x 3¼ inch), high precision photographic cameras set about 40 inches apart. Enlarged stereo pairs of photographic images of the scene under study are then placed in an optical comparator, allowing a viewer to see them as a single, three-dimensional image.[29]

In the simplest available method, a highly trained operator traces the object of interest in the comparator, recording contours of the three-dimensional image, which are in turn transmitted mechanically to a drafting table. Photo-theodolites to meet several different photogrammetric needs are available. Such equipment can be made more effective by adding such equipment as advanced plotters using microcomputers, color-graphic video terminals, and tape or disk storage.

Until recently, photogrammetric recording has been relatively expensive. Although basic equipment can be acquired for about $60,000, a complete, high-accuracy, system can cost as much as $1 million. Stereo-plotters alone may cost nearly $250,000. Some architectural and engineering firms have simply been unable to absorb such an expense. While traditional equipment costs have been stabilizing, labor costs have risen.

In addition, concern over rapid obsolescence has discouraged investment in standard photogrammetric equipment. Currently, the "bread and butter work," much of which is aerial, but which uses the much the same stereo-plotters and comparators, is conducted for industrial quality control and State highway and transportation departments.

Recent innovations that depend heavily on digital computer applications rather than precision optics to achieve accuracy, are dramatically lowering the costs of precision photogrammetry. The following two examples illustrate this trend. Even if new developments are still inappropriate for certain applications where extremely high accuracy is required, they will be useful in supplementing traditional methods.

Stereo Analytic Plotting Systems.—Stereo analytic systems represent a simplified approach to photogrammetry.[30] Like traditional stereo photogrammetric methods, they use photography as the basis for making three-dimensional measurements. However, they can often use 35mm stereo slides, black and white, or color film, taken with normal commercial lenses, instead of the larger format photographs used in traditional instruments. The technology has aided in preserving accurate images of site features, particularly those of a subtle nature, which will be destroyed by the process of excavation, as well as of objects before their removal from the archaeological context.

Such instruments allow an operator to examine a stereo pair of color slides and, to record the

---

[27] Thomas Sever, NASA, personal communication, 1985.

[28] See, for example, U.S. Department of the Interior, National Park Service, Preservation Assistance Division, "Using Photogrammetry To Monitor Materials Deterioration and Structural Problems on Historic Buildings: The Dorchester Heights Monument: A Case Study" (Washington, DC: no date).

[29] See Hans Foramitti, "Classical and Photogrammetric Methods Used in Surveying Architectural Monuments," *Preserving Monuments and Historic Buildings*, Museums and Monuments Series 14 (Paris: UNESCO, 1972).

[30] One such instrument is made by H. Dell Foster Associates of San Antonio, TX, for the American Schools of Oriental Research and field tested by archaeologists working in the Middle East. See "Computers Aid Study of Ancient Artifacts," *New York Times*, Aug. 13, 1985, for a description of the H. Dell Foster, MACO 35/70 system. It uses either 35mm or 70mm film.

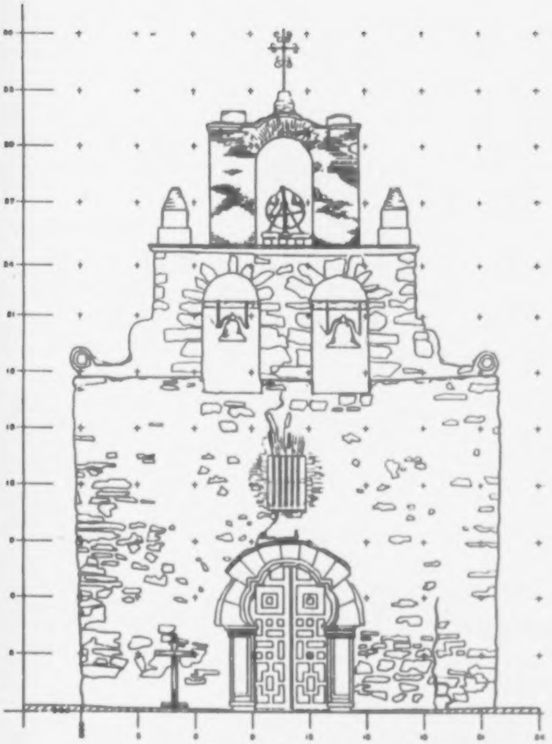


Photo credit: Southwest Region, National Park Service

Drawing of Mission Espada, San Antonio, Texas, from stereophotographs using the MACO 35/70 analytic stereo-plotter.

three-dimensional positions of points within the scene directly on an associated computer, which can be a minicomputer or inexpensive microcomputer. Computer software corrects for lens and image errors and produces high precision measurements of features selected by the operator. One of the advantages of analytic systems is that they require less highly trained operators than traditional photogrammetric systems.

The NPS Southwest Regional Office is using a stereo analytic system to prepare drawings of buildings under its care, assess the condition of ruined pueblos and mission buildings, and record the petroglyphs at Inscription Rock, El Morro National Monument.

Computer Image Analysis.—Technicians at NASA's Earth Resources Laboratory in Bay St. Louis, Mississippi, are developing a system that should eventually circumvent the need for a trained technician to examine the stereo image directly.[31] Instead, through a technique called digital scanning, each photograph is optically scanned by an instrument that converts the photographic density at each point in both stereo photographs to a number proportional to the density and stores it in a computer. Within a few minutes, the device can digitize and store the information from images as large as 18 inches on a side. Computer software then corrects for any photographic distortions and compares the information on the two photographs.

When analyzing the images, by searching for edges in the image, much the way a human operator of a stereo comparator does, the computer can generate a three-dimensional line drawing of the building or object in the pair of photographs. The resultant drawing can then be printed out on a computer-driven plotter. At the present time, the technique requires a mainframe computer. However, the associated digital scanner is relatively inexpensive. The accuracy of such a system is limited primarily by the inherent accuracy of the photographic images, and by the accuracy of the digital scanner. It should be able to generate high-quality drawings from high-quality photographs.

These promising applications, however, have barely begun to affect the way photogrammetric recording is undertaken in historic preservation. Architectural photogrammetry has not been developed in the United States at a level comparable to that found in countries such as Austria, France, the Federal Republic of Germany, and in other European countries. This is in part because the United States has few facilities for training in the use of these methods, and in part because the use of accurate measured drawings is given relatively low priority in the preservation of structures and landscapes. High costs have also been cited as an important factor, yet other countries have found them to be cost-effective for generating highly accurate drawings.

Even if a company has already invested in basic equipment and trained staff, the use of architectural photogrammetry is cost-effective, as such methods lead to a marked increase in accuracy and productivity over the labor-intensive requirements for preparing measured drawings using traditional methods depending on direct measurements. For this reason developing countries such as Indonesia, Peru, and Turkey now have their own photogrammetric services.

---

[31] OTA site visit, March 1986.

There is a critical need for improved information exchanges between the preservation community and the American Society of Photogrammetry and Remote Sensing, which publishes detailed technical information. The cheaper, easier-to-use, photogrammetric methods resulting from the development of analytical instruments and large-image digitizers may represent a significant breakthrough, but the benefits are still largely unrealized.[32]

Video Tape and Optical Disk Methods

Video and optical disk technologies can both be powerful tools for survey and identification. Video techniques have proved especially helpful in the survey of underwater archaeological resources, and for rapid survey of city neighborhoods and historic structures.[33] Optical disks can be used to store video, film, and still images of cultural resources for rapid retrieval and comparison (see *Chapter 5: Preservation Information*).

Issues in Remote Sensing

Training in Remote Sensing Techniques.—Though many of the recently developed remote sensing techniques are extremely powerful, preservation professionals have not used them effectively, primarily because they are often unfamiliar with the utility of such techniques, and lack training in their use. Remote sensing methods, techniques, and equipment are developing so fast preservationists often cannot keep up.[*] This is a disadvantage for preservation because it is impossible to develop technical or methodological standards when hardware and software formats change rapidly.

Because of the utility of remote sensing techniques, a vigorous government program (perhaps within the Department of the Interior) to assist archaeologists and other preservation professionals in using remote sensing techniques may be appropriate. Recently, NASA provided training in remote sensing methods to several archaeologists through its Earth Resources Laboratories in Bay St. Louis, Mississippi. Such a program might serve as a model for other Federal efforts.

During the 1970s, the National Park Service within its Southwest Regional Office developed a research program that successfully demonstrated the utility of remote sensing techniques for managing cultural resources. That office has published a series of reports of high utility for understanding and applying remote sensing technologies. However, in recent years, the staff and funding of that office have been reduced and its research activities have dwindled.

Predictive Modeling

Predictive locational modeling is the general term used for a group of techniques used to predict the distribution of archaeologically significant material in a region. Not only is it potentially useful for finding sites, it can be an integral part of the scientific explanation of archaeological remains.

Although such techniques are significant both for research and for cultural resource management, misconceptions about them abound among archaeologists and cultural resource managers. They have in some cases been oversold. For example, some thought it would be possible to use remote sensing and other methods to survey an area, find all the sites, and assess their relative significance. This has not proved to be the case. Sites have been missed, and their significance not appreciated.[34] With considerably more research, predictive locational modeling will likely be a powerful tool for management as well as research. Improvements in the techniques are of particular importance because it could give better control over the resource base which is being destroyed at an alarming rate by both environmental and human factors.

---

[32] Such research institutions as the Center for Remote Sensing at Boston University, and the Center for Earth Observations and Remote Sensing at the University of Colorado, can be expected to enhance the transfer of remote sensing techniques into preservation.

[33] Andrew Lippman, "Movie-Maps: An Application of the Optical Videodisc to Computer Graphics," *Proceedings of SIGGRAPH '80: Seventh Annual Conference on Computer Graphics and Interactive Techniques*, Seattle, WA, July 14-18, 1980.

[*] For example, instead of detecting 10 to 15 shades of grey in the visible part of the spectrum from black and white photography, digital remotely sensed data allow discrimination among 256 shades in a variety of spectral bands, including the infrared. Processing this enormous amount of data requires a large computer that can quickly and efficiently process large amounts of information.

[34] See the various articles in Jim Judge and Lynn Sebastian, *Cultural Resource Predictive Modeling*, Report of Bureau of Land Management, Denver Service Center, Denver, CO (in draft). This document is an attempt to bring together the theory and practice of predictive modeling in one place.

Archaeologists use two distinct families of approaches. One is an empirical, or inferential, approach that attempts to extrapolate from known distributions within a surveyed sample of a region to unsurveyed areas. The other, which is complementary, is a theoretical, or deductive, approach that is based on underlying assumptions about how people might have behaved, given a particular paleolandscape (e.g., climate, soil productivity, landform characteristics, availability of game).[35]

Although the empirical, correlational models work to a certain level, they do not explain why people behaved as they did in the past. Deductive models, on the other hand, explain why people behaved as we observe, but they have not been widely applied because they are more difficult to develop. Thus their potential accuracy is uncertain.

Many archaeologists and historians have expressed severe reservations about how effective predictive modeling might be as a management tool and fear that it might be misused in an effort to avoid costly ground survey or detailed archival research. The models are not likely to tell us where all the sites are because it is unlikely that human behavior can be determined to that degree. Because human behavior is responsive both to predictable needs and essentially unpredictable historical circumstances, even highly sophisticated locational models cannot be expected to be completely accurate.

Their use for locating sites implies a set of assumptions (i.e., a model) about how the culture under study works. A model that incorporates too few parameters may lead to incorrect results. Sites are just one part of an entire cultural system that includes intellectual (e.g., philosophy and theology) as well as material determinants. Predicting locations of sites without considering the entire organizational system (as much as can be known) of the prehistoric society will lead to incorrect results.[36] Societies include not only living and working areas, but such elements as planning, division of labor, and mobility, among others. In addition, many have expressed the concern that models may help in locating typical sites, but may be totally useless in locating atypical ones.[37] Adequate protection of historic and prehistoric properties requires unique as well as typical sites be identified and protected.

From a management perspective, it is the anomalies that may be important because they draw the attention of the public and are likely to suffer most from visitation. For example, Stonehenge is celebrated throughout literature in part because it is unique. Yet there are thousands of smaller and less famous stone circles throughout the British Isles. The latter provide more information about prehistoric culture than does Stonehenge. In the United States, the Serpent Mound in central Ohio is a remarkable prehistoric landform that often serves as an illustrative example of the accomplishments of the prehistoric Indians who constructed the mounds. However, it too is exceptional among the thousands of mounds in the Central United States.

From the standpoint of predictive modeling, the anomalies may not be so important. For example, ordinary trash is of less interest to the lay person than the trash of a celebrity, but of greater interest to the archaeologist or historian attempting to understand how the average person lives. Nevertheless, because of this and related concerns, several participants noted that predictive modeling may not result in great cost savings. It may provide other benefits, including better land-use planning and better understanding of now extinct subsistence and settlement systems. Finally, it may find its greatest utility as a guide to field sampling.

---

[35] William C. Smith and James C. Chatters, "Archaeological Predictive Modeling: The Yakima Firing Center," Central Washington Archaeological Survey and Geographic Information Systems Laboratory, Central Washington University, Ellensburg, WA, March 1986.

[36] For example, like trying to predict the patterns of telephone usage in a city, taking into account only the residential usage.

[37] For example, we may learn that a given culture prefers settling within a certain distance from a streambed and are able successfully to predict sites on that basis. However, such a model would not necessarily allow for a variety of special-purpose sites, or for the case of a community from the same culture that decided to break with tradition because of political differences and settled much farther away.

One of the big problems for developing predictive locational models is the difficulty in comparing data generated by one archaeologist with data from another. Neither predictive locational models nor the way basic field data are accumulated exhibit very much standardization.

In using remote sensing or predictive modeling, it is essential to define the research problem because preliminary evaluation often constitutes the basis for research and later interpretation and preservation.[38] A search of archival materials is extremely important.

Identification and Survey of Submerged Cultural Resources

Because many of the technologies used for survey and identification of submerged cultural resources are unique to underwater archaeology, they are treated separately in this section. A variety of techniques are used to locate underwater sites. The simplest techniques mimic those used on land and include random searches as well as controlled coverage by scuba[39] divers positioned at regular intervals along swimlines. Although simple approaches and accidental finds have

---

[38] For example, site-landform correlations. Some types of environmental considerations and some cultural patterns change the landscape in identifiable, systematic ways. Seeing where sites cluster in one part of the region can provide one with guidelines for sampling elsewhere.

[39] Self Contained Underwater Breathing Apparatus.

Point Reyes National Seashore

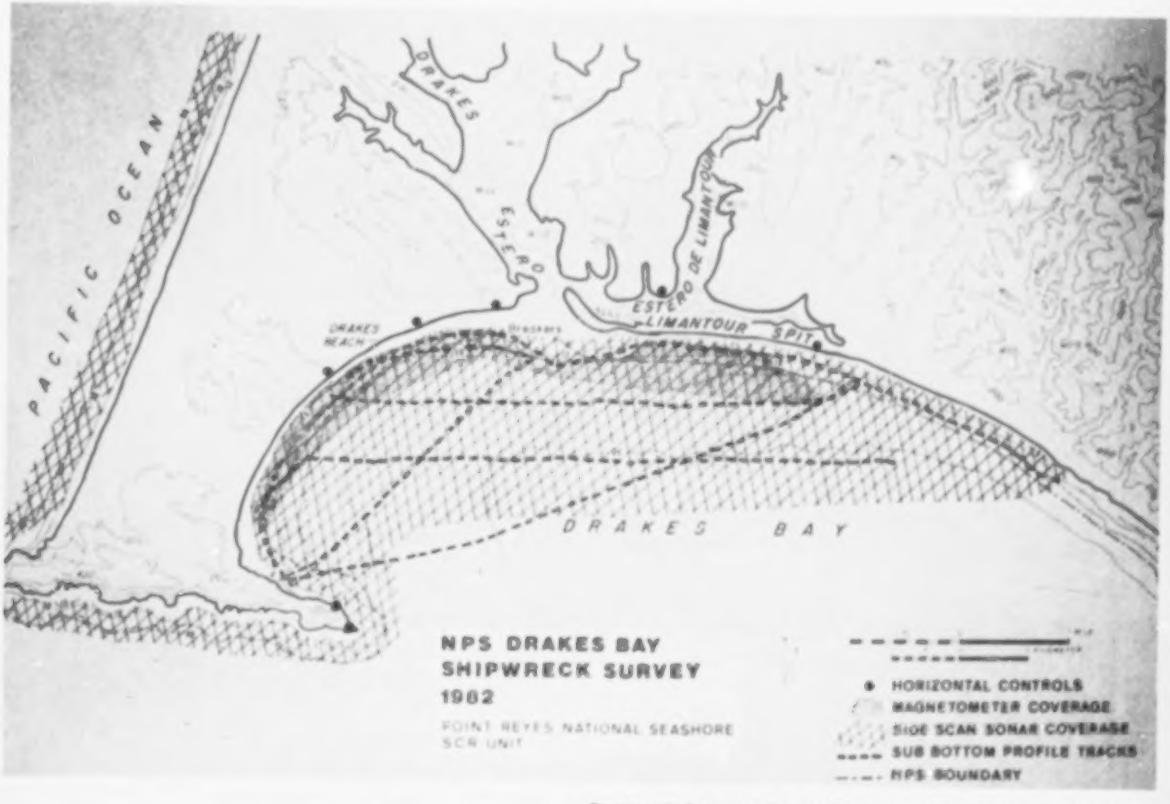


Photo credit: Submerged Cultural Resources Unit (SCRU), National Park Service

This map illustrates the degree of overlap between the various remote sensing equipment profiles employed to cover a particular area at Point Reyes National Seashore during a 1983 survey.

yielded some significant discoveries, most are haphazard and unpredictable.

The most promising, efficient, and accurate approaches to resource location rely on nondestructive, electronic remote sensing technologies. Underwater remote sensing surveys are conducted in compliance with environmental regulations prior to activities such as dredging or offshore mineral development that would disturb or destroy sites. These surveys employ a variety of instruments including magnetometers, sub-bottom profilers, side-scan sonar, precision fathometers, and electronic positioners. Refinements and advances in sub-bottom profiling, and side-scan sonar[40] have been driven, primarily, by the demands of the military and the gas and petroleum industries. Until these technologies were incorporated into underwater archaeology, quick and accurate large-area surveys of the ocean floor were virtually impossible to carry out.

Surveys made with these remote sensing methods result in electronic records, patterns of images or signals in either analog strip charts or digital records. These images indicate both normal and anomalous bottom and sub-bottom phenomena. As in land archaeology, the sources of anomalous signals can only be identified as archaeological material through examination *in situ*. It is important for underwater archaeologists to continue building a "catalog" of representative signals matched with specific anomalous image sources to examine and test new underwater contexts such as estuaries and deep water more effectively and efficiently.

- *Side-scan sonar* sends out acoustic pulses from an instrument located below a survey ship. A receiver on the ship detects the reflected signal and creates an image of the ocean floor based on the return time and direction of each reflected signal. It produces excellent images of the topography of the ocean floor, including structures and shipwrecks; it cannot detect materials covered by sediments. Unlike sub-bottom profiling, side-scan sonar can cover wide areas of the ocean bed, enabling the quick and accurate mapping of such geological phenomena as drowned river systems.
- *Sub-bottom profilers*[41] are sonar instruments that generate acoustical pulses downward. These pulses in turn are reflected back from sediment layers below the ocean floor. Each layer produces a discrete echo that is received and printed on strip charts. The range of images approximate to a high degree of resolution (less than a meter) the sub-bottom levels encountered. Sub-bottom profilers were designed for use in deep water and,

Side-Scan Sonar Unit

Photo credit: National Oceanic and Atmospheric Administration

The side-scan sonar unit is being lowered into the water at the *U.S.S. Monitor* site, off Cape Hatteras, NC.

---

[40] C.J. Ingram, "High-Resolution Side Scan Sonar/Subbottom Profiling to 6,000 Mile Water Depth," paper presented at the Pacific Congress on Marine Technology, Hawaii, Mar. 24-28, 1986.

[41] Milton B. Dobrin, *Introduction to Geophysical Prospecting* (New York: McGraw-Hill, 1976).

Photo credit: Garry Kozak, Klein Associates

Side-scan sonar of the *The Atlantic*, a wooden, side-wheel U.S. steamship sunk in 1852, in the Canadian waters of Lake Erie. The ship rests nearly upright, 160 feet below the surface. Because it lies in cold, freshwater, it is remarkably well-preserved.

until recently, were not well suited for use in shallow water. However, modifications now enable them to operate in less than 6 m of water. They are limited to surveying only the area directly beneath their vessels and, thus, must make many closely spaced sweeps over large survey tracts.

- *Magnetometers*[42] sense the magnetic field anomalies created by ferrous materials on the ocean floor. Therefore they can only locate shipwrecks and other historic sites containing such metals. Their major shortcoming is that they must be relatively close to their targets because the targets' magnetic fields attenuate rapidly (by the inverse square) as the distance between them and magnetometric sensors increases. Magnetometers cannot easily trace weak signals or anomalies, such as those detected from under sediments, to their sources. Greater use of airborne magnetometry could lead to faster, broader, and more accurate coverage within survey perimeters. Even remote sensing from space as it is refined to more deeply penetrate the water's surface could soon be applied to underwater archaeological site identification and management, as it has been to hydrography.[43]
- *Remotely operated vehicles (ROVs):* ROVs have been undergoing rapid change and development, going deeper to bring clearer pictures than ever before of the seabed. De-

---

[42] Ibid.

[43] J. Barto Arnold, III, "Remote Sensing in Archaeology," *The International Journal of Nautical Archaeology and Underwater Exploration*, 1981.

veloped in response to the needs of the military and oil, gas, and minerals exploration companies, they are replacing human divers in a great many underwater tasks. They can remain submerged for weeks to survey huge areas of the ocean floor.

For example, the historic discovery of the wreck *Titanic*[44] in April 1985, was achieved through an unmanned craft, the *Argo*, tethered to a ship by 13,000 feet of cable. Outfitted with television cameras, high-powered lights, and sonar scanners, it revealed new information about an environment that had previously been closed to archaeological research. The *Titanic* was later explored by a manned vehicle, the *Alvin*, and a remotely operated craft, *Jason, Jr.* in an attempt to gather photographic and other data on the wreck's condition.[45]

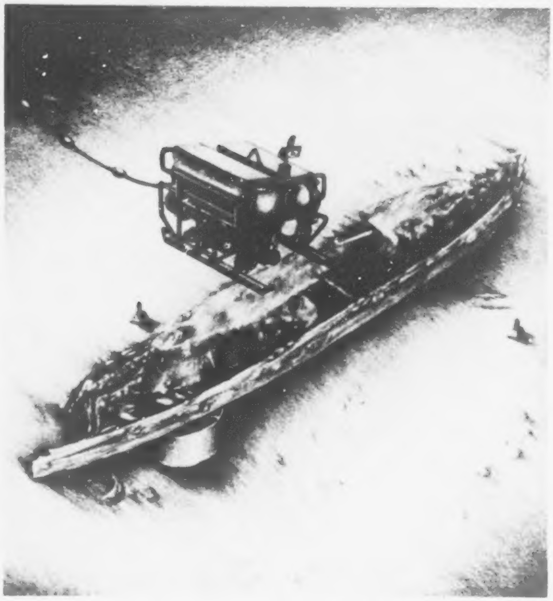


Photo credit: Eastport, International

Artist's rendering of a remotely operated vehicle, DEEP DRONE, which hovers over *U.S.S. Monitor*, lying 230 feet deep off the coast of Cape Hatteras, NC

---

[44] Robert D. Ballard, "How We Found the *Titanic*," *National Geographic* 168, 1985, pp. 696-722.

[45] Walter Sullivan, "Manned Sub Descends To View the Titanic," *New York Times*, July 15, 1986, p. C1.

DOCUMENTATION AND ANALYSIS

Documentation and analysis are the heart of the research process. It is here that a research plan, or design, is particularly important, because excavation, coring, test trenches, and dismantling the outer layers of an historic structure may destroy some or all of the resource. Techniques that provide nondestructive, objective ways of documenting cultural resources are extremely important, because the primary way for others to judge the quality of the analytical results is to examine the original data. It is therefore especially important that the data be as free of the investigator's bias as possible, and that data recovery methods be designed to answer a wide variety of potential research questions.[46]

In many cases, new techniques and methods have made possible the collection or interpretation of data far beyond what was possible just a few years ago. For example, in the excavation of the prehistoric Koster Site in west-central Illinois,[47] the development of flotation techniques for collecting plant materials, seeds, and pollen led to a much better appreciation of the complexity of the prehistoric Indian societies that inhabited the site over the centuries and their ability to adapt to new conditions.

Refinements in radiocarbon dating have made possible the determination of more accurate dates for historic structures and landscapes as well as prehistoric sites. Archaeomagnetic and obsidian hydration dating techniques, developed in the 1970s, have restructured our understanding of the dates of certain archaeological sites for which there is no datable wood.

---

[46] See Allan E. Kane, William D. Lipe, Ruthann Knudson, Timothy A. Kohler, Steven E. James, Patrick Hogan, and Lynne Sebastian, "The Dolores Archaeological Program Research Design," *Dolores Archaeological Program: Field Investigations and Analysis—1978* (Denver, CO: Engineering and Research Center, Bureau of Reclamation, U.S. Department of the Interior, November 1983) for a detailed view of a wide-ranging research design.

[47] S. Struever and F.A. Holton, *Koster: Americans in Search of Their Prehistoric Past* (New York: Signet, 1979).

Technologies

This section discusses some representative techniques (table 7) used by archaeologists and historians to analyze prehistoric and historic cultural resources. The technologies discussed are illustrative and not intended to be inclusive.

Excavation

Site Sampling and Evaluation.—As archaeologists attempt to tackle ever more sophisticated problems, requiring finer distinctions among sites and groups of sites, the relevance of how they collect materials from a site and where they decide to dig within a site becomes more important.[48] Site sampling and evaluation techniques allow the archaeologist to determine: 1) which sites to excavate, 2) where to excavate within the site, 3) where the site boundaries are, and 4) how to collect materials from within each site. For example, in excavating Pueblo Alto, a major prehistoric Chaco Canyon village, in the late 1970s, only 10 percent of the structure was actually excavated. National Park Service archaeologists used sampling techniques to decide where to dig, and saved most of the structure for future research.[49]

Table 7.—Technologies for Gathering and Analyzing Data

Excavation:
- Coring tools
- Probing tools
- Digging tools
- Screens
- Sifters
- Sorters
- Flotation techniques
- Sample collection devices
- Site sampling devices
- Portable generators
- Soil micromorphology
- Soil profile techniques (interpreting and recording)
- Temporary shelters over sites during excavation

Inspection:
- Visual
- X-ray
- Infrared
- Moisture meters
- Neutron/gamma-ray spectroscopy

Documentation:
- Computers
- Bar code generators
- Drawings
- Photographic cameras
- Video cameras

Analysis:
- Computers
- Geographic Information Systems
- Chemical

SOURCE: Office of Technology Assessment.

Sampling makes extensive use of magnetometers, soil resistivity methods, subsurface radar, and other remote sensing technologies also employed for survey and identification, to find remnants of structures, and other evidence of human activity.

Archaeologists and landscape architects also employ coring techniques to sample the earth for evidence of human activity. Refinements in these techniques for other purposes will benefit the sampling process.[50]

Inspection

Neutron/Gamma-Ray Spectroscopy.—A promising new technology, developed originally to analyze the chemical composition of lunar soil, makes use of neutron/gamma-ray spectroscopy. The technique makes use of a radioactive source (californium 252) that emits high-energy neutrons. Because of their high energy, neutrons may travel as much as several meters, depending on the type of material they penetrate. In using the technique, the experimenter places the neutron source against the material to be analyzed, and the resulting neutrons pass through it, striking atoms of various elements within. The atoms emit gamma rays (high-energy electromagnetic waves) characteristic of the atom struck. A gamma-ray detector on the other side of the material determines the intensity and energy of the gamma-rays so emitted. Analysis of the spectrum of these gamma rays allows the experimenter to determine the chemical composition of the material between the neutron source and the gamma-ray detector.

---

[48] Timothy A. Kohler, Carl J. Phagan, and Eric Blinman, "Sources of Confounding Variability in Archaeological Collections," Dolores Archaeological Program Technical Report Number DAP-282, Dec. 4, 1982.

[49] James Judge, Southern Methodist University, personal communication, 1985.

[50] See Julie K. Stein, "Coring Archaeological Sites," *American Antiquity*, 1986, pp. 505-527, for a discussion of coring technology and history of its use.

Photo credit: Ray A. Williamson

National Park Service archaeologists excavating pithouse remains in Chaco Canyon National Historical Park, NM.

This nondestructive technology, recently "transferred" to preservation has been successfully field tested on historic structures at Colonial Williamsburg, Virginia, and in Venice, Italy. The deep-penetrating technology enables scientists to determine the kind, distribution, and amount of contaminants within structural materials. Such contaminants may result in the destruction of the material. For example, in an investigation of a smokehouse in Williamsburg, the technique was used to determine the concentration of damaging salts in the smokehouse roof. The technique could also be used to monitor the effectiveness of stone consolidation. It constitutes a significant advance over previous techniques, such as core sample analysis, which is destructive; electrical conductivity, which measures only surface moisture and is affected by salts; and neutron thermalization, which is limited to shallow surface diagnosis.[51]

Infrared, Ultraviolet, and X-ray Inspection.—Such techniques, which make use of analytical methods depending on wavelengths of light beyond the visible range for humans, have greatly expanded the ability of architects to determine the original colors of paint, or to "see" features otherwise invisible to the naked eye. For example, by using ultraviolet light, architects examining Gunston Hall in Virginia, were able to determine that many of the carved wooden decorations originally on the interior walls had been removed at some time in the past.[52] Even high-intensity visible light may reveal details or "ghost" images and contours that are invisible in normal illumination.

X-ray analysis makes possible the inspection of features hidden from view behind structural materials, or even within a structure. For example, it has been used to reveal the presence of hand-wrought nails connecting balusters to a handrail, confirming that the staircase was original 18th century construction, and not a restoration.[53] Portable, relatively inexpensive units, make field inspection practical in a variety of conditions. X-rays can penetrate most common building materials, but to varying depths. Conventional plaster and wood are most easily penetrated; most metals, masonry, and earth absorb X-rays easily.

---

[51] L.G. Evans, J.I Trombka, R.A. Livingston, and T.H. Taylor, "Neutron/Gamma-Ray Techniques for Investigating the Deterioration of Historic Buildings," *Nuclear Instruments and Methods in Physics Research* A242 (Amsterdam: North Holland, 1986).

[52] Thomas J. Colin, "Solving the Mystery of Gunston Hall," *Historic Preservation*, June 1984, pp. 40-45.

In practice, the X-ray unit is set up on one side of the construction medium under study. A film pack containing a specially coated screen which fluoresces when struck by X-rays, contains high-speed photographic film, which is exposed by the fluorescent screen. By using Polaroid film in the film pack, the structural analyst can see results immediately and, if necessary, reposition the apparatus to produce the desired results.

In 1981, X-ray analysis revealed the answer to long-standing questions regarding details on the internal structure of the dome of Thomas Jefferson's Virginia home, Monticello, whether it was, in fact constructed "in Delorme's manner." The evidence was found in Jefferson's personal notebook on dome design and remodeling the property. That document indicates that Jefferson intended, in constructing the dome of Monticello, to incorporate techniques he learned during his tenure as American Minister to France. Developed by Philibert Delorme, a 16th century architect in the French court, the approach employed wooden planks laminated in short, curved segments to form long, continuous structural ribs that could then be used to vault arched spaces. This technique represented an improvement over traditional timber vaulting methods in that it was lightweight, inexpensive, and easily and quickly assembled.

In the absence of more detailed notes and drawings, and because destructive analytical devices are inappropriate for such an architecturally and historically significant building, X-ray examination proved ideal for penetrating the dome's surfaces. X-ray techniques confirmed the degree to which Jefferson varied his application of Delorme's technique.[54] Important findings include the use in Monticello's dome of four laminations per rib rather than the two per rib of Delorme. In addition, Monticello's dome features wrought nails and spikes instead of mortises, tenons, and pegs for attaching structural elements. X-ray technology showed clearly the innovation behind Jefferson's adaptation.

Chemical and Physical Analysis

A variety of methods are used to determine the chemical constituents and physical properties of paint, wallpaper, and materials incorporated within historic structures. Most involve the laboratory analysis of samples removed from a historic structure. For example, in examining fragments of wallpaper used at different times in Gunston Hall, researchers have analyzed six different wallpapers and found that each of them contained wood pulp, which indicated that they all dated from later than 1825, as earlier paper was made from rags.[55]

Photo credit: Preservation Assistance Division, National Park Service

Infrared Moisture Detection, Rome. Demonstration of remotely operated unit.

---

[53] See David McLaren Hart, "X-Ray Inspection of Historic Structures: An Aid To Dating and Structural Analyses," *Technology & Conservation*, summer 1977, pp. 10-27, for a comphrehensive summary of X-ray techniques.

[54] Douglas Harnsberger, "In Delorme's Manner," *APT Bulletin*, vol. XII, No. 4, 1981.

[55] Ibid.

Chemical analysis of stone can aid in determining the quarry from which it was mined. Chemical analysis of wood can aid in determining whether structural and decorative or applied wood is part of the original fabric or newer and, therefore a replacement or addition.

However, proper diagnosis of the condition of historic structures begins with visual inspection, as exterior signs of decay and degradation in buildings are often obvious. The senses of smell and touch and hearing also identify deterioration. Musty odors and damp surfaces suggest the presence of damaging levels of moisture; certain sounds can indicate whether or not a structural member is firm or weakened. Examination of the soundness of roofing systems reveals much about possible water damage.[56] Tables 8 through 11 present a variety of diagnostic tests that can be used in examining damage to wood, masonry, iron and steel, and reinforced concrete.

Information Analysis

Computerized Geographic Information Systems.—Geographic Information Systems (GIS) are

---

[56] Forrest Wilson, "Building Diagnostics," *Architectural Technology*, winter 1985.

Table 8.—Technologies for Analyzing the Physical Condition of Wood

Diagnose	Test method	+Advantages −Disadvantages
Decay, species	Visual	+good preliminary step −other tests should follow to determine internal conditions, stability
Strength and grade	Visual	+Well-suited for grading inspection +gives a measure of structural adequacy −limited to accessibility, may be impractical if grade marks painted over
Density, strength, degree of degradation	Manual probing	+good to detect surface decay +fast, easy to identify advanced decay −other tests needed to assess internal quality −not all surfaces may be accessible −cannot detect internal decay
Moisture content	Dielectric moisture meters, power-loss meter	+easy to use, will not upset surface −limited range: 0% to 39% moisture content −sensitive principally to surface of sample −accuracy impaired when moisture gradient present −reading affected by specimen density, chemical treatments or decay
	Resistance-type moisture meter	+meter simple, rugged; readout in direct units +calibrations for grades and species −limited range: 7% to 30% moisture content −data influenced by some preservatives, fire retardants and decay
	Electrical resistance probe	+measures changes in long-term moisture content remotely +can be built into structure −used only in research −limited range: 7% to 35% moisture content
Strength, modulus of elasticity	Ultrasonic, pulse velocity	+equipment portable, fast, and readily adaptable for field use −affected by wood characteristics that are not flaws, such as moisture content
	Stress-wave propagation	+portable, light, inexpensive −requires trained personnel
Moisture content	Weight test, oven-drying	+accurate at any level of moisture content −takes time, requires lab test-equipment
Grain direction, irregularities, decay, splits, knots, moisture content, insect damage, location and size of members	Radiographic	+provides permanent record +equipment light, portable, easy to use −radiation is unhealthy, requires shielding −initial cost high −field development not complete −specimen must be accessible on both sides

SOURCE: Forrest Wilson, "Building Diagnostics" *Architectural Technology*, winter 1985; Neal Fitzsimmons; U.S. Department of Housing and Urban Development.

Table 9.—Technologies for Analyzing the Physical Condition of Masonry

Diagnose	Test method	+Advantages −Disadvantages
Flexural bond strength	Load testing	+accurate −destructive
Shear strength or diagonal strength	Load testing	+accurate −destructive
Water absorption	Weighing, dry and saturated	+accurate −time-consuming
Size	Visual measurement	+fast, requires little skill −will not determine strength or durability
Warpage	Visual inspection	+fast, requires little skill −will not determine strength or durability
Imperviousness	Ink test	+fast −will not determine strength or durability
Chemical resistance	Acid dripping	+useful if exposure to certain chemicals is anticipated −will not determine strength or durability
Crazing	Autoclave test	+reliable test −safety precautions required −will not determine strength or durability
Leakage, water permeance	Spray test	+rate of leakage and water permeance be observed +used for comparison of masonry specimen; simple modifications make useful for in-situ testing −will not determine strength or durability, other than that inferred from porosity
Compressive strength	Masonry prisms	+results reliable if taken from actual building materials −results uncertain if materials different from actual building
Structural soundness, mortar bond, filled cells	Hammer test (light tapping)	+fast approximation −requires skilled tester with good hearing −may require additional testing to validate findings
Inner cell grout, wall thickness	Probe holes	+small holes from test easily patched +requires only semiskilled evaluator −an approximation, requires many drill holes unless combined with fiber optics
Continuity, voids, cracks, estimate of compressive strength	Ultrasonics (low frequency)	+accurate evaluation of several parameters −requires skilled, experienced operators −expensive
Voids and reinforcement	Radiography	+accurate evaluation of parameters; permanent record on film −requires access of both sides of specimen −requires safety precautions; expensive
Location of reinforcement	Pachometer	+requires fast, semiskilled operator +gives locations and depth of reinforcement −used only for light reinforcement; difficult to interpret if both joint and cell reinforcement used.

SOURCE: Forrest Wilson, "Building Diagnostics" *Architectural Technology*, winter 1985; Neal Fitzsimmons; U.S. Department of Housing and Urban Development.

computerized database systems in which the data are explicitly spatial in nature and organization. Such systems can be applied in studies of prehistoric and historic settlement patterns, and to planning for future development.

A complete GIS includes both computer software and hardware. It is capable of merging and analyzing a wide variety of data for their information content and displaying them graphically. A system capable of processing large amounts of information quickly (on minicomputers or mainframe computers) would cost on the order of $50,000 or more, although smaller, less capable systems for microcomputers (such as P-MAP, and RIPS) are available at much lower costs. Examples of the more extensive systems, in the public domain, include MOSS/MAPS (Bureau of Land Management), Geographical Resources Analysis Support System (GRASS)[57] (under development by the Construction Engineering Research Laboratory of the Army Corps of Engineers), and SAGIS (National Park Service).[58]

---

[57] J. Westervelt, W. Goran, and M. Shapiro, "Development and Applications of Grass: The Geographical Resources Analysis Support System," manuscript, U.S. Army Construction Engineering Research Laboratory, Champaign.

[58] Remotely sensed data are ideally suited for analysis by GIS.

Table 10.—Technologies for Analyzing the Physical Condition of Reinforced Concrete

Diagnose	Test method	+Advantages −Disadvantages
Surface flaws	Visual, optical	+inexpensive +no special equipment needed +reveals defects other methods won't −provides information on surface only
Differential movements over time	Surveying	+provides cyclical relationships between deformation, temperature and load −immediate interpretations not available −trained surveyor required
Joint survey, expansion, contraction, cracking, variety of conditions	Visual joint inspection	+inexpensive initial first step in a more in-depth investigation +most applicable to foundations, walls, slabs −trained observer required for data collection and evaluation
Internal cracks, voids, flaws	Fiber optics visual survey	+yields clear, high-resolution image of remote inspection areas −requires path to surface; may require multiple boreholes
Surface hardness—relative quality of concrete	Rebound hammer	+inexpensive, fast; can be used by inexperienced personnel −indications of strength not accurate −results affected by condition of concrete surface −requires correlation between rebound value and concrete
Compressive strength	Penetration, Windsor probe	+equipment is simple, durable +field operation requires minimum training −accuracy depends on location of test and accuracy of depth gauge −slightly damages small area of concrete −provides accurate strength determination only with correlation of depth of penetration and concrete strength
Moisture content	Dielectric	+equipment readily automated −used in the past only in laboratories −accuracy of 25% −equipment very expensive, tests only for moisture content
Slab thickness, re-bar location	Electrical resistivity	+equipment easy to use −limited to pavements and on-grade slabs −results inaccurate, affected by air entrainment density, moisture, salt content, and temperature gradients
Locate ferromagnetic elements, location and depth	Magnetic cover meters, Pachometers	+light, portable, easy to operate, inexpensive −battery equipment will not operate satisfactorily below 32° F −good results only with one layer of re-bar −will not work well with mesh
Growing internal flaws	Acoustic emission, stress waves	+equipment simple, easy to operate +data gathering requires minimal training −data interpretation requires an expert −background noise distorts results −computer recommended for triangulation of flaw location −used only when structure is loaded and flaws increasing

SOURCE: Forrest Wilson, "Building Diagnostics" *Architectural Technology*, winter 1985, Neal Fitzsimmons; U.S. Department of Housing and Urban Development.

Table 11.—Technologies for Analyzing the Physical Condition of Iron and Steel

Diagnose	Test method	+ Advantages – Disadvantages
Surface characteristics, flaws, corrosion, pits, etc.	Visual, optical, boroscopes, fiber-optics, etc.	+ permits inspection of surface and hidden surfaces if access available – detect only visible flaws on surface or below surface through access channels
Material separations (open to surface)	Liquid penetrant containing dye	+ permits inspection of complex shapes in a single operation + inexpensive, easy to apply, portable – shows only defects open to the surface – messy, with irrelevant indications – results depend on operator's ability – results must be carefully controlled
Cracks, seams, laps, voids, porosity, and inclusions	Magnetic particle	+ simple, inexpensive + senses flaws down to ¼ inch as well as surface flaws + not applicable to nonmagnetic metals or materials – messy, careful surface preparatio required – irrelevant indications often occur – results depend on operator's skill
Voids, porosity, inclusions, and cracks	X-ray and gamma-ray radiographics	+ detects both internal and external flaws + portable + permanent record – expensive; heavy – health hazard, requires shielding – complex shapes difficult to analyze
Surface-finish discontinuities, cracks, seams, variation in alloy composition or heat treatment	Eddy current	+ moderate cost; readily automated + portable; permanent record available + can be adapted to comparative analysis – useful on conductive materials only – shallow penetration – reference standards often required – provides only qualitative comparison
Yield strength, yield point, tensile strength, modulus of elasticity, compressive strength	Coupon	+ fast, accurate results of physical and mechanical values – destructive to sample removed for testing

SOURCE: Forrest Wilson, "Building Diagnostics" *Architectural Technology*, winter 1985; Neal Fitzsimmons; U.S. Department of Housing and Urban Development.

These systems are available for a wide variety of analytical and management chores because many cultural resource data are spatial in nature. For example, the goal of much archaeological research is to discern patterns in the distribution of artifacts, structures, or other cultural materials across the Earth's surface. GIS can also be used to relate data from different parts of a site at a variety of scales. In archaeology, GIS methods have been used most extensively to predict the occurrence of sites in a given region of interest (predictive locational modeling).

GIS can be especially useful for analyzing landscapes. The Army, for example, has used existing GIS technologies to map vegetation, slopes, and archaeological sites across a landscape.[59] The system can plot every known site. Army technicians can even show how the landscape looks at different times of the day or season. Although the Army uses such information for planning military exercises, and other strictly military purposes, some of these techniques could be transferred into the civilian realm.

The expense of the technology, however, has limited its use by archaeologists and landscape architects. **Regional GIS centers, that maintained shared environmental and other databases, would make it possible for these groups to gain access to advanced GIS methods and help spread this technological innovation more rapidly and effectively through the preservation community.** Such centers could provide training for archaeologists and others in GIS methods. They are likely to be highly effective within the university community, where archaeologists and many other professionals using GIS technology can work together on common problems.

---

[59] Constance Ramieriz, Department of the Army, personal communication, 1986.

Dating Techniques

The development of a series of physical dating techniques (table 12) by physicists and chemists provides one of the best examples of the successful application of technology to archaeology over the last 30 years.[60] The following discusses two of those methods.

Radiocarbon (Carbon-14) Dating.—Developed by W.F. Libby and his co-workers at the University of Chicago just after World War II, radiocarbon dating is the most widely used and best-known dating method. It relies on the fact that all living organisms contain carbon atoms, an extremely small percentage of which (about one part in a trillion) is the mildly radioactive isotope, carbon-14. While the organism is still living, the percentage of carbon-14 is maintained in equilibrium through exchange with atmospheric carbon. However, when it dies, no further exchange is possible and the carbon-14 decays slowly (with a half-life of about 6,000 years).

This technique is capable of providing ages of organic materials for the last 30,000 to 70,000 years (depending on the size of the sample and the experimental conditions). For periods of 5,000 years or less, and sample sizes of a gram or more,[61] the technique can determine the age of a sample with a typical precision of ±20 to ±150 years. However, the use of radiocarbon techniques for the more recent past (17th to 20th century), for example to distinguish renovations from original construction, requires special techniques. Both natural and anthropogenic factors that have affected the ratios of ^{14}C to ^{12}C make unambiguous dating for this time period particularly difficult.

Beginning in the late 1970s, the use of particle accelerators[62] have made possible what is called direct, or ion, counting (as opposed to the conventional decay counting) permitting reductions in the size of the sample required for age determination of factors of 1,000 to 1 million.[63] This improvement makes possible the dating of extremely small samples that were impossible to date several years ago. It also pushes back the epoch for which carbon dating is possible by several thousand years. It might even make possible the dating of European Palaeolithic cave paintings or prehistoric American pictographs painted with organic pigment. However, this dating method also means that archaeologists must institute new methods to prevent contamination by historic materials (for instance, by packaging materials).

Table 12.—Dating Prehistoric Sites

Method	Materials	Range of time
Dendrochronology	Wood	0 to 7,000 years
Radiocarbon	Organic materiais (wood, seeds, bones, shells)	0 to 50,000 years
Archaeomagnetic	Ferrous-bearing material, heated in the past (clay, stone firehearths)	0 to 10,000 years
Obsidian hydration	Obsidian	0 to 10,000 years
Thermoluminescence	Ceramics, burned rocks, stalagmites	0 to hundreds of thousands of years
Fission tracks	Volcanic glass, minerals rich in uranium	0 to several hundreds of thousands of years
Potassium-argon	Volcanic lava	1,000 to 1,000 million years

SOURCES: Joseph W. Michels, *Dating Methods in Archaeology* (New York: Seminar Press, 1973); Tony Hackens "How Science Unlocks the Secrets of the Past," *The Courier*, July 1985, pp. 12-22.

---

[60] See Joseph W. Michels, *Dating Methods in Archaeology* (New York: Seminar Press, 1973) for a general discussion of dating methods.

[61] Although a gram of material seems small, some fragments of wood or other organic samples are a gram or smaller. Dating them would therefore destroy them completely.

[62] See, for example, Christopher Chippendale, "Radiocarbon Comes of Age at Oxford," *New Scientist*, July 21, 1983, pp. 181-184.

[63] Decay counting methods typically require samples of a gram or more of carbon. The newer methods require only micrograms to milligrams of carbon.

Archaeomagnetic Dating.—Archaeomagnetic dating has been widely applied since the 1970s but is still being perfected. It has been most useful in the American Southwest, where dendrochronology (tree ring dating) can be used for calibration. The method depends on the geophysical fact that Earth's magnetic field changes direction and strength over time. When an iron-bearing stone material (e.g., a fire hearth) is heated sufficiently to release molecules of ferrous materials within the hearth from their rigid molecular alignments, they become free to realign themselves in the local magnetic field. That orientation is fixed as the material cools. Comparison today of the molecules' orientation relative to the current field direction (which is constantly changing) can yield an estimate of the date at which the stone archaeological sample was last fired.

The archaeomagnetic scientist maps a set of magnetic pole positions over time based on samples of known ages. The unknown sample is then related to this set. The accuracy of the dates therefore depends on: 1) the rate of the magnetic changes through time—the faster the change, the more accurate the date that results from the comparison; and 2) how well one can collect and measure the orientation of the remnant magnetism in the sample. Recently, the process has become more sophisticated, and at the same time archaeologists have become more rigorous in their use of archaeomagnetic results.

Because archaeomagnetic dating requires independently derived master curves of change of Earth's magnetic field over time, the technique cannot be applied to regions that have no existing master curves. Therefore, every effort should be made to collect samples in these areas so master curves can be developed. Unfortunately, many archaeologists in areas lacking master archaeomagnetic curves are not attuned to the potential of these samples, and because such samples will not help them immediately in dating their sites, they tend not to collect them. However, if support were made available to collect such samples, it would be possible to develop a national archaeomagnetism database.

Archaeomagnetic dating techniques are a direct outgrowth of the interests of geophysicists in the magnetic history of the Earth. In archaeomagnetism, samples collected for archaeology are useful to geophysicists trying to understand the long-term behavior of Earth's magnetic field.

Soil Sciences, Sedimentology, and Geomorphology.—The set of techniques derived from soil science, sedimentology, and geomorphology have been recognized and applied by archaeologists for decades. Until recently, however, such techniques have been invoked primarily to reconstruct likely paleo-environments. Earth sciences have been used to explain the unique proliferation of early people sites in East and South Africa, the movements of Pleistocene hunter-gatherers in glacial Europe, and the conditions favorable to the emergence of agriculture in the Near East and Mesoamerica.

More recent interests in processes of site formation have expanded the domain of inquiry and methodologies to the point where they can identify and often date modes of site occupation, abandonment, and burial. Although such techniques need a great deal of further research, scientists can also explain what environmental processes cause certain sites to maintain integrity despite weathering and the ravages of time. In archaeologically rich areas, distinctive landforms and soil layers identifiable by texture and color, as well as soil chemistry, may serve as regional benchmarks for locating the surfaces of sites, isolating unique environments favored by particular ancient cultures, and for marking occupation sequences over time.

Such methods, applied to understanding the prehistoric case, may provide important data for modern soil problems. For example, study of soil productivity and soil salinity in ancient Mesopotamia may suggest techniques to apply for today's problems of increasing soil salinity in western irrigated soils.[64]

The earth sciences have much to contribute to the preservation and management of cultural resources, in part because they involve study of the interaction of natural and cultural resources. Because of this management potential, for example in locating archaeological sites,[65] an appreciation of the benefits and liabilities of earth science research is especially critical to Federal or State managers of cultural resources. In particular, the National Park Service and the U.S. Army Corps of Engineers recognize the potential of geomorphology and soil science as integral components of large-scale research design. In the future it will be important to focus on the potential of the specialized approaches to particular archaeological problems, such as soils sciences, in the interests of maximizing overall research yield, boosting efficiency, and addressing preservation issues in a systematic manner.

---

[64] Diane E. Gelburd, "Managing Salinity: Lessons From the Past," *Journal of Soil and Water Conservation* 40:329-331, 1985.

It will also be important to characterize more completely the chemical constituents and chemical interactions of artifacts, structures, and archaeological sediments.

Technologies for Underwater Archaeology

Individuals exploring the sea bottom have a wide array of technologies at their disposal. Deep water technologies such as tethered and free roaming remotely operated vehicles (ROVs) and saturation diving are exerting a profound effect on data recovery in underwater archaeology and maritime preservation.

Technical improvements involving the remote detection of submerged cultural sites completely covered by sand and other sediments would significantly aid underwater archaeological research. Refinements in such techniques as magnetometry, which would allow archaeologists to determine which sites to excavate and where to excavate within them, would benefit the entire underwater archaeological process.

Scuba Diving.—Archaeologists make extensive use of scuba diving equipment and techniques for exploring and excavating sites in shallow waters.

Deep Sea Diving.—The use of saturation divers and deep-diving systems to collect samples at depths totally unattainable to conventional divers has been a major technical innovation. Saturation divers are now able to work at extreme depth for prolonged periods. Bottom times are no longer a function of depth, as they are with scuba diving, and each dive can last for many hours instead of minutes. Breathing an atmosphere of mixed helium-oxygen, divers can attain depths of over 1,000 feet, although decompression afterward may require several days. Habitats, lockout submersibles, and tethered deep-diving systems deploy saturation divers to their destinations.

Remotely Operated Vehicles.—ROVs were discussed earlier in the examination of technologies for discovery. However, they have an important

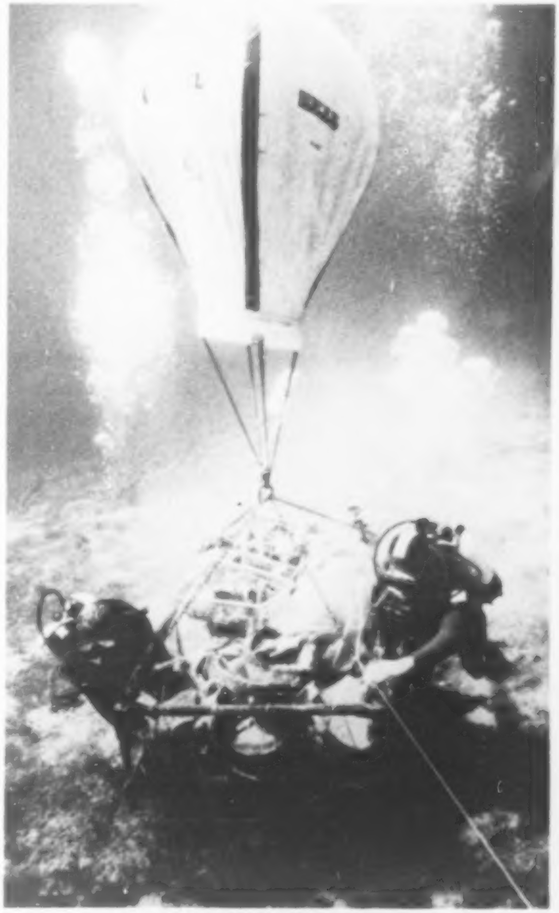


Photo credit: Institute of Nautical Archaeology

A lifting balloon assists underwater archaeologists in raising artifacts.

---

[65] L. E. Wildesen and Y.T. Witherspoon, "Locating Significant Archaeological Sites by Landform Analysis in Central Oregon," presented at the Northwest Anthropological Conference, April 1985, Ellensburg, WA.

role in gathering data, either using photographic and video techniques, or collecting samples. *Scorpio*, a particular type of new ROV,[66] is now being equipped with remotely controlled manipulators. New ROVs are now capable of achieving depths of up to 13,000 feet and are armed with specialized work packages capable of cleaning oil rig platforms and recovering a vast array of objects.[67] The costs of ROVs are extremely high, however (see *Chapter 7: Preservation Policy*).

Underwater Excavation Technologies.—These techniques range from the extremely simple, such as hand-fanning, to the complex, such as controlled blasting, and include the use of blowers, prop wash deflectors, air hammers, and chisels. Excavation required in dark or "black" water can be virtually impossible to carry out, even in relatively calm, shallow water. Specially designed coffer dams such as that being applied at the Yorktown Archaeological Park in Yorktown, Virginia,[68] are improving the ability of divers to find their way in heavily silted waters. In Yorktown, excavation of an 18th century shipwreck is carried out within a steel enclosure filled with river water that is clarified by commercial filtration units. Normal visibility in the York River is usually less than 1 foot. The filtration process increases the visibility inside the protective coffer dam to more than 20 feet. A pier connecting the dam to the shore permits ready access to visitors who are encouraged to observe underwater archaeologists working at the site and to familiarize themselves with part of the archaeological research process.

---

[66] Jonathan B. Tucker, "Submersibles Reach New Depths," *High Technology*, February 1986.

[67] The University of New Hampshire owns possibly the most advanced ROV, EAVE-EAST. It is autonomous and outfitted with five microprocessors to sense data on altitude, depth, obstacles, and power consumption. Research continues to impart greater dexterity of manipulation and better systems for autonomy.

[68] John D. Broadwater, Division of Historic Landmarks, York, VA, personal communication, 1986.

ISSUES

Archaeology

1. *Excavation is the last resort in archaeological research.*

Although the public generally associates excavation of sites with archaeology, archaeologists today generally consider excavation to be a last resort, primarily because excavation severely disturbs or even destroys a site and prevents later reexamination and reinterpretation. For many archaeological research problems, the examination of surface remains can yield information just as critical for understanding prehistoric society as excavation. In addition, rather than focus on the site per se, archaeologists today generally view their research in terms of regional, rather than site, analysis. They excavate sites in order to investigate hypotheses generated for a regional context, and investigate the climate, the zoology, and botany of a region as well as its geology and geomorphology.

This point of view represents a change from an earlier approach to archaeology.[69] In the first place, not excavating leaves the remains in place for future research as new techniques allow finer and finer levels of analysis. In the second, techniques are continually being developed that can provide information about a site or area without destroying it. In general, **archaeologists need to excavate less and record the sites they do excavate more carefully.**[70] **Not only should they record the positions and kinds of artifacts more carefully, they should record plant and animal remains found in different layers of the soil, as well as soil color and chemical makeup.**

In addition, as archaeologists continue to increase the amount of data recorded and materials saved when excavating, it becomes proportionately more costly to excavate. Therefore technologies that reduce costs are becoming increasingly important.

Nevertheless, excavation is often the only way to gather sufficient information on an ancient culture. Advanced techniques can make the task of excavation more efficient, more complete, and more objective. Excavation methods have improved over time and are increasingly designed to preserve more of a given site from the destruction resulting from excavation.

---

[69] David J. Meltzer, et al. (eds.), *American Archaeology Past and Future* (Washington, DC: Smithsonian Institution Press, 1986), for several articles concerning the changes that have taken place in the practice of archaeology in the United States in the last 50 years.

[70] E. Harris, *Principles of Stratigraphy* (London: Academic Press, 1979).

2. *Data recording methods should be improved to make them more complete and more objective.*

New methods also allow archaeologists to standardize the process of gathering data so they are less prone to do onsite interpretation that could lead to bias in their final results. Standardization is especially important as other archaeologists cannot replicate the excavation of a given site. Even sites that are similar and located in the same geographical area are unique in many aspects. By contrast, the science of physics or astronomy depends on the scientist's ability to check each other's work by replicating crucial experiments or observations.

Improvements are especially needed in technologies for constructing accurate three-dimensional maps in the field in order to accurately locate artifacts found on a surface or within a room, because the exact placement of an artifact may provide clues as to how it was used.

One simple, relatively inexpensive technique for recording field data is to use bar code generators to produce bar codes in the field for the purpose of characterizing artifacts. The bar code can then be attached to the artifact for identification in the lab.[71] Recording the excavation with photographs or video cameras allows later interpretation in the laboratory.[72] Orthophotographic techniques, which allow recording of an excavation by means of overhead stereo cameras, need to be made cheaper.

3. *Adequate samples should be collected for later analysis.*

Scientific methods for archaeology are now becoming sophisticated enough that it is profitable to collect material such as soils, cores, and profile peels, that might be analyzed later by microtechniques under development today. Some archaeologists have made and stored collections of soils and cores, but this practice appears to be the exception rather than the rule. Nor are such procedures generally taught in field schools today. Here again, archaeologists need to standardize the collection and recording of samples so material from one site may be compared with that from another.

Material from each excavation is unique from a biophysical and biochemical point of view, so the requirements of data collection at a site can become very specific. Archaeologists are well trained in recovering artifacts, but only relatively recently have they begun to turn their attention to the geological, biophysical, biochemical material. They need experience in the relevant discipline to do this. It is otherwise too easy to make mistakes in deciding exactly what to collect and how to collect and process it. With advanced dating techniques such as radiocarbon, thermoluminescence, and obsidian hydration, for example, it is increasingly important to know more about the surrounding biochemical environment, because techniques now in development use much more sensitive equipment that can date much smaller samples than in the past.

4. *Remote sensing and other locational technologies can be used by looters as well as professional archaeologists.*

Unfortunately, the same remote sensing technologies that are available for preservation can be used for increased looting of archaeological sites because many of the data (e.g., the Landsat data and most aerial photos) are available to the public. As archaeologists improve their sophistication in remote sensing techniques, so too will those who wish to exploit cultural resources for personal gain.

This is particularly true for shipwrecks, given the currently clouded legal situation vis-a-vis title to submerged cultural resources (see *Chapter 7: Technology and Preservation Policy*). As long as salvors and artifact hunters are allowed to recover the contents of shipwrecks in U.S. waters they will employ a variety of advanced technologies for finding shipwrecks and their contents. At this point, those who would protect these aspects of U.S. cultural history are not generally finding these sites first and therefore cannot protect them. In States where laws against the looting of historic shipwrecks within designated waters are strongly enforced, improved monitoring and surveillance equipment (see *Chapter 4: Restoration, Conservation, Maintenance, and Protection*) would aid underwater archaeologists and cultural resource managers in developing strategies to safeguard shipwreck sites from illegal intrusion.

---

[71] Bar code readers and generators are now available even for portable lap computers. Lap computers can also be used to record data and for controlling processes in the field.

[72] For example, color video technology, which allows one to see changes in soil color as the excavation takes place may improve the accuracy of interpretation of the site. Three-dimensional holograms for recording excavation information might also improve the excavation process.

Underwater Archaeology

1. *Underwater archaeology is highly dependent on advanced technology.*

More than any other preservation field, underwater archaeology depends on a wide array of costly techniques and equipment. Underwater archaeologists confront a host of practical problems, even dangers, that their colleagues working on dry land do not. These problems relate to underwater environmental conditions and include breathing, currents, cold, depth, turbidity, and hostile marine animals; they also relate to time limitations on research and the degree to which remains might be buried beneath sediments or concretion.

The available technologies are generally adequate to the preservation tasks but they are often too expensive. In addition, only a small core of professionals experienced in their use is available. Future research should focus on developing more sensitive, low-cost methods and instrumentation, and on exploiting new sources of information.

2. *A research design is extremely important in determining the appropriate technology to apply to the study of underwater cultural resources.*

In part because underwater archaeology is a relatively new subdiscipline of archaeology, some underwater archaeologists have given relatively little attention to developing a detailed research plan, or design. Yet, in the absence of a detailed research design, including plans for curation of excavated materials, the research project may fall short of its investigator's intent. Archaeologists should not excavate unless they can ensure and specify within a research design, that the materials recovered from the marine environment can be properly housed, conserved, and maintained.

As one archaeologist has complained:

> In the real world of shipwreck archaeology, the commitment to excavation is developed before the conceptualization of a significant rationale for doing it. This is understandable in a CRM [cultural resources management] milieu, i.e., some sort of mitigation must be carried out on a site threatened by dredging or other bottom disturbing construction activities. This, however, is actually rarely the case; usually an institutional researcher has obtained money to excavate a shipwreck, then he may or may not develop a comprehensive statement on why he is going to excavate it—but usually not.[73]

Historic Structures

1. *Nondestructive analytical techniques need to be developed for studying historic structures.*

Given the pace of rehabilitation spurred by preservation tax incentives and the sometimes rapid degradation of some materials from air and water-borne pollutants, the need for more powerful, nondestructive analytical techniques for determining the nature, extent, causes, and results of deterioration and failure of materials is critical. Currently, relevant technologies range from relatively simple, inexpensive hand-held moisture meters to sophisticated neutron/gamma-ray detectors.

2. *Knowledge of the behavior of historic building materials is insufficient.*

Even many preservationists, architects, and engineers have a relatively weak grasp of the detailed behavior of historic building materials. Recognition of the need for careful, scientific testing and monitoring of such materials has emerged only recently. The reactions of historic materials exposed to certain environments have been mis-

---

[73] Daniel J. Lenihan and Larry Murphy, "Considerations for Research Designs in Shipwreck Archaeology," *Underwater Archaeology: The Challenge Before Us, The Proceedings of the Twelfth Conference on Underwater Archaeology*, Gordon P. Watts, Jr. (ed.) (San Marino, CA: Fortran Eight, 1981).

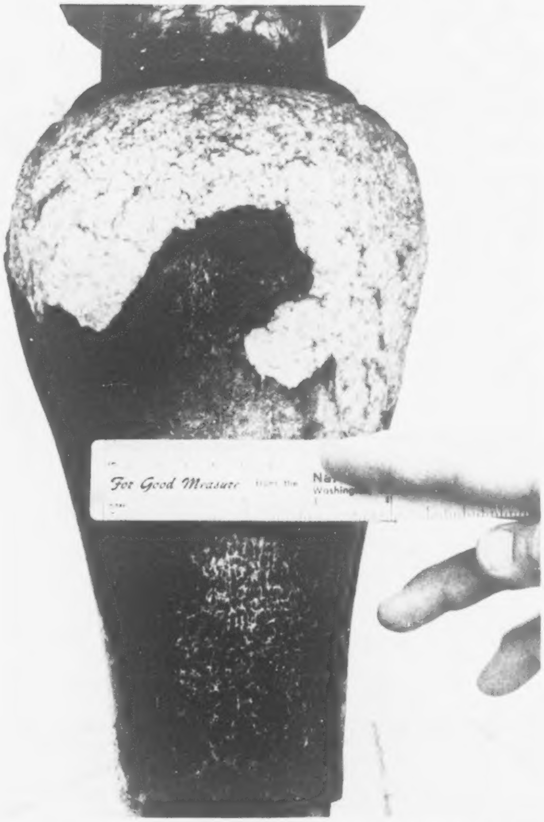


Photo credit: D. Dwornik, U.S. Geological Survey

Exfoliation of gypsum crust. Georgia marble baluster after 75 years of exposure in Washington, DC. The black crust containing gypsum is a result of sulfur dioxide attack on marble.

understood, which has resulted in some serious conservation problems today. Corrosive interactions introduced into the environment through new and not yet fully monitored industrial and chemical processes are compounding these problems.

In addition, many of the Nation's historic buildings erected between the 1880s and early 1940s were the results of intense competition among product manufacturers, architects, and builders, many of whom closely guarded the secrets of their proprietary designs and processes. This was a very active period in building. Because building materials were not generally tested, their strengths and shortcomings were not fully understood. Often, for example, the most easily carved and, therefore, the least durable stones were placed incorrectly at the tops of buildings or within cornices where they became highly vulnerable to weathering. Poor construction methods, inadequate craftsmanship, and general corner-cutting were almost forced by timeframes and budgets. The installation of incompatible materials in close proximity to each other has resulted in serious problems. For example, oxidation both stains and damages masonry in contact with iron, steel, and copper. Also, changes over time in building shapes toward flattened facades and profiles have all but eliminated highly effective moisture-controlling design features such as projecting string and belt courses, pediments, and water tables. "Most systems and products were developed through trial and error. It was an age of exploitation of building materials and systems. Unfortunately, we are left with that legacy."[74]

The National Bureau of Standards' Center for Building Technology is applying some of the most advanced technologies for characterizing the microstructure and the physical, chemical, and mechanical properties of organic, inorganic, and composite building materials. They employ an array of complex instruments (table 13) to determine and measure the mechanisms of the degradation and decay of building materials.

3. *Preliminary research into the physical history of the structure can focus the use of technology.*

Where construction and repair/rehabilitation documentation has been retained, a search of those records can give basic information on which to build a technological testing program. For instance, the names of quarries for the various types of stone in many of the monuments located in the Mall area of Washington, DC, came from construction documents saved by the Army Corps of Engineers and the National Park Service. In a few cases, the specific vein at the quarry could be identified. This information allows

---

[74] See Baird M. Smith, "Diagnosis of Nonstructural Problems in Historic Masonry Buildings," *Conservation of Historic Stone Buildings*, Report of the Committee on Conservation of Historic Stone Buildings and Monuments, National Materials Advisory Board, Commission on Engineering and Technical Systems, National Research Council (Washington, DC: National Academy Press, 1982), pp. 212-214.

Table 13.—Major Equipment of the National Bureau of Standards' Center for Building Technology

- scanning electron and light microscopes
- X-ray diffractometer
- thermal analyzers
- ultraviolet visible and Fourier transform infrared spectrophotometers
- mechanical testing machines
- environmental cabinets
- accelerated weathering chambers
- gel permeation chromatograph
- ion and gas chromatographs
- digital data-collection systems
- minicomputers and microcomputers
- image analyzer

SOURCE: Office of Technology Assessment.

managers to use chemical testing much more specifically because the material has been so closely identified before the testing starts.

4. *The sharing of technologies can make more advanced documentation and analysis of historic structures available.*

Gulf Islands National Seashore, for example, has cooperative agreements with many Florida State bureaus to carry out sophisticated examinations on their historic structures.

5. *Historic structures frequently include additions or have lost portions that reflect an ongoing process of use and change.*

Technologies that can help to illuminate that process of development over time by showing where and how changes and additions have been made will help to reveal the richness of social and cultural change. The documentation and analysis of those changes can also be used to communicate the story of the structure to a wider audience through information developments.

6. *Historic structures should be viewed and analyzed in the context of their full setting, rather than as single buildings divorced from their milieu.*

Thus, many of the techniques involved with landscapes (see below) can be applied to structures and sites as well.

Landscapes

The survey of U.S. prehistoric and historic landscapes is still in its infancy. In part as a result of the lack of adequate survey, the constituency for locating and preserving significant historic landscapes has not yet developed fully, though it is growing.[75] An interdisciplinary team approach is needed in which anthropologists, archaeologists, architects, and historians work together with landscape architects in conducting a broad-based survey of American landscapes.[76]

There are three basic steps in identifying historic landscapes:

1. identifying and accessing records of the known resources;
2. identifying previously unidentified historic landscapes; and
3. recording, storing, and augmenting the newly acquired data.

After being identified (see figure 2), the significance of the landscape must be evaluated against criteria developed for the National Register of Historic Places.[77]

Participants in this assessment raised the following issues related to the discovery and analysis of prehistoric and historic landscapes:

1. *Public officials and individuals are often unaware of the value and significance of historic landscapes.*

Traditionally, historic preservationists have worked from the grassroots. They have built local constituencies that have insisted on the value of a given structure or archaeological site and

---

[75] See, for example, Eleanor M. Peck, Keith Morgan, and Cynthia Zaitzevsky (eds.), *Olmsted in Massachusetts: The Public Legacy* (Brookline, MA: Massachusetts Association for Olmsted Parks, 1983), for an example of a State inventory of a specific class of designed landscapes.

[76] *Olmsted Historic Landscape Preservation Program: Guidelines and Criteria for Implementation* (Boston, MA: Commonwealth of Massachusetts Office of Environmental Affairs, April 1985).

[77] Timothy Keller and Genevieve P. Keller, "How To Evaluate and Nominate Designed Historic Landscapes," *National Register of Historic Places Bulletin 18*, U.S. Department of the Interior, National Park Service, in press.

Figure 2.—Categories of Historic Landscapes

	Treatment					
	Restoration	Rehabilitation	Reconstruction	Interpretation	Conservation	Typical landscape preservation projects
Residential grounds	✓		✓	✓		Mary Washington House, Fredericksburg, VA GWSM, Inc. The Garden Club of Virginia
Monument grounds	✓	✓		✓		Statue of Liberty, New York, NY Norman T. Newton National Park Service
Public building grounds	✓	✓				Original Governor's Mansion, Helena, MT Richard E. Mayer Montana State Parks Division
Garden	✓	✓	✓			Stratford Garden Restoration, Potomac River, VA GWSM, Inc. The Garden Club of Virginia
Minor public grounds (e.g., town square, parklet, traffic circle)	✓			✓		Pioneer Square, Seattle, WA Jones & Jones City of Seattle
Botanical garden	✓	✓			✓	Sannonburg Gardens, Canandaigua, NY Noredo A. Rotunno Sannonburg Gardens Committee
Fort	✓	✓		✓		Fort Stanwix National Monument, Rome, NY Dureya & Wilhelmi, P.C. National Park Service
Battlefield		✓		✓	✓	Rosebud Battlefield, Montana Richard E. Mayer Montana State Parks Division
Cemetery		✓			✓	Cemeteries, New Harmony, IN Kane & Carruth, P.C.
Streetscape		✓		✓		Main Street Project, Hot Springs, SD Preservation/Urban/Design, Inc. National Trust Chicago Mid-West Office
Estate	✓	✓			✓	Gamble Plantation, Manatee County, FL Lane L. Marshall & Associates, Inc. State of Florida
Park		✓		✓	✓	Cherokee Park Restoration, Louisville, KY Johnson, Johnson & Roy, Inc. Louisville Metropolitan Park & Recreation Board
Working farm	✓		✓			Old World Wisconsin, Eagle, WI William H. Tishler State Historical Society of Wisconsin
Museum village	✓	✓	✓			Williamsburg, VA Shurcliff, Hopkins, Parker, Barton & Belden—Staff Landscape Architects Colonial Williamsburg Foundation
District	✓			✓	✓	Heritage Square, Los Angeles, CA Merrill W. Winans Cultural Heritage Foundation
Town		✓		✓	✓	Town of New Harmony, New Harmony, IN Kane & Carruth, P.C.
Prehistoric site				✓	✓	Cahokia Mounds, near East St. Louis, IL Edward J. Keating Illinois Department of Conservation
Park system		✓		✓	✓	Survey Olmsted Parks System, Buffalo, NY Patricia M. O'Donnell Highways, Parks & Recreation Historical Preservation Division & Landmark Society of the Niagara Frontier

SOURCE: *Landscape Architecture*, January 1981.

sought State or National help in preserving it. However, in landscapes, the local constituency that identifies landscape value often do not exist, in part because adequate information is not available. For example, in the case of designed historic landscapes, most people are unaware that they were designed, and why it may be important to maintain the integrity of that design. For cultural or vernacular landscapes, the local constituency may appreciate their significance the least just because they are so familiar.

Where a constituency has developed, it has often acted to enlarge the scope of historic districts. For example, in Jefferson County, Kentucky,[78] a site consisting of a few farm houses and auxiliary buildings was nominated to the Register. However, the local people realized that the houses had little to do with the significance of the area. They considered the agricultural patterns, the associations of the families, the stonework, the fences, and other components as significant. The local people, working through their certified local government (CLG), did the research necessary to expand the scale of the nomination to a 400- to 500-acre district. The landscape elements became major components imparting significance to the district.

As citizens become more aware of the influence of historic landscapes in their lives and landscapes' importance to the history of the Nation, local nominations to the National Register of Historic Places are likely to increase in number and size.

2. *Landscape records are often poorly stored and cataloged.*

One of the important components of surveying the States for additional significant historic landscapes is to be aware of those already cataloged. Unfortunately, the state of knowledge of sites so identified is quite poor; until quite recently, it was not possible to use even the National Register of Historic Places as a source to compile a list of significant landscapes because the Register does not list them as landscapes but as structures, if at all. In many cases, landscapes are included on the National Register by virtue of the fact that they are settings for historic structures. In some cases, the landscape may have greater significance than the structure.

The contents of the National Register are now in a computer database, which should make it possible to locate nearly all landscapes listed in the National Register. **Improving local and national databases and making historical data generally more available should improve the quality and extent of landscape preservation.**

3. *Landscape study is highly interdisciplinary.*

The study of prehistoric and historic landscapes requires the use of a variety of information sources, including folklore, oral history,[79] historic maps, drawings, and paintings, climate information, tax records, and ethnohistorical accounts. Analysis draws on a variety of techniques, including sociological techniques, environmental design, and a variety of geographical techniques developed for the analysis of land cover and landforms. This characteristic is one of the strengths of landscape preservation. Because landscapes often transcend political boundaries, they may be profitably studied on a regional, as well as multidisciplinary, basis. The study of landscapes and the study of ecology both share such a regional scope.[80]

4. *Landscapes are subject to a variety of stresses that change their condition and character over time.*

Because landscapes can change so radically over time as a result of urban development, the growth of bushes and trees, and wind and rain erosion (see *Chapter 4: Restoration, Conservation, Maintenance, and Protection* for discussion of such stresses), it may be extremely difficult to locate the full extent of cultural and historic designed landscapes in the midst of radically altered surroundings and successive changes. Landscapes may either increase or decrease in significance depending on their integrity and surroundings.

---

[78] Timothy Keller, Land and Community Associates, personal communication, 1986.

[79] See, for example, Mary Hufford, "Culture and Cultivation of Nature: The Pinelands National Reserve," *Folklife Annual 1985* (Washington, DC: Library of Congress, 1985).

[80] For example, several rivers that start in the Blue Ridge Mountains of Virginia empty into the Atlantic in North and South Carolina. The environmental problems caused by human use of these rivers are indeed regional.

One of the biggest technical problems in understanding cultural landscapes is that different cultural components of the same landscape are generally associated with several different periods of history. Both cultural and ecological factors can cause irreversible changes that further complicate study of the landscape. Disentangling these various components and understanding how different ages shaped the landscape to fit their purposes can be a formidable task. Unless researchers can untangle the various components of different periods it is nearly impossible to reconstruct a landscape perfectly for any *one* period.[81]

For example, one study[82] of the historic landscapes around Mont Dardon in southern Burgundy found that the pre-Christian era Celts responded to the land much differently than their Roman conquerors, who altered the landscape to suit their military needs. The Celts preferred to live on the more easily defendable heights, but the Romans forced them to move into the valleys where their army could control them more easily. Inhabitants from the Middle Ages and the modern periods in their turn dramatically altered the Roman landscape. Even in North America, where written records are only a few hundred years old, cultural manipulation of the landscape may involve many different cultures extending more than 10,000 years into the past.

5. *Appropriate application of existing technology is important.*

The locations of many designed gardens or parks are known because they are part of local lore. However, they may be buried, or so altered in appearance that they are unrecognizable. In these cases, landscape architects and historians employ well-known, standard archaeological and historical research techniques to determine their original extent, form, and contents. For example, the existence of the terraced garden associated with the Paca House, the winter home of William Paca, one of the signers of the Declaration of Independence, in the city of Annapolis, was well known from 18th century historical accounts. However, when restoration of the Paca House began in 1965, the original garden was buried under a parking lot and only a few details of its extent, form, and contents were provided in these writings. No drawing of the garden existed. The current Paca garden is a conjectural reconstruction developed from detailed archaeology of the immediate area and considerable historical research on the types of flowers, shrubs, and trees that Paca would have likely planted.[83]

6. *The techniques appropriate to different size landscapes are different.*

Cultural Landscapes.—Computer modeling and remote sensing techniques provide a powerful set of tools for the interpretation and evaluation of cultural landscapes, which may extend over hundreds or thousands of acres. An important goal of the investigator of a prehistoric or historic landscape is to be able to "read" the landscape for the clues (or signatures) it gives to the relationships human societies bear to the land and how they interact with and alter it over time. Technology can aid that process by making the varieties of information about landscapes much more accessible. Such systems can be used to plot the potential changes to a landscape as a result of plant growth, grazing, forestry, and other temporal alterations of landscape components.

In discussing the use of such advanced techniques, participants in this study noted that many administrators who control the purse strings regard GIS, remote sensing, and other advanced methods as expensive, yet for large areas, it can be one of the cheapest methods for gathering data, especially because it allows access to information impossible to retrieve in any other way. Public administrators need to understand how remote sensing may be cost-effective in certain applications. They also need to understand the limi-

---

[81] For example, 17th century Salem, MA, had structures and land use patterns which originated in, and were characteristic of, the 16th century.

[82] Carole L. Crumley, "Archaeological Reconnaissance at Mont Dardon, France," *Archaeology*, May-June 1983, pp. 14-17, 20; and Scott L.H. Madry, "Remote Sensing in Archaeology," *Archaeology*, May-June 1983, pp. 18-19. They used remote sensing and computer analysis, as well as traditional historical and archaeological research methods, to investigate the patterns of two millenia of settlement and land use in the area. Their goal was to illuminate the ways in which different cultures have defined and used the local landscape.

[83] Bill McDougald, "William Paca's Colonial Garden," *Southern Living*, May 1984.

William Paca House and Garden, Annapolis, MD

Photo credit: Ray A. Williamson

After being buried under a 200-room hotel, a parking lot, and bus station, this 18th century garden was restored in the 1970s based on the results of careful research by archaeologists, architects, landscape architects, and historians.

tations of such technology in order to avoid applying it inappropriately.

Designed Landscapes.—For historic parks, gardens, and other designed landscapes, remote sensing and GIS find less application. Searches of historical records and traditional archaeological and botanical techniques are the techniques of choice. Many of these techniques may be improved through the innovative use of computer hardware and software. (See, for example, *Chapter 5: Preservation Information*.)

Historic landscape analysis and evaluation also require the identification, study, and retrieval of historic plant types. Identifying the plants appropriate to a given historic period and region is one of the major tasks facing landscape preservationists. Their task is complicated by the fact that plant taxonomies have changed radically over time. In addition, thousands of varieties of trees, shrubs, and plants have been introduced into the United States from other parts of the world over the past 200 years. Certain varieties, such as the American chestnut, have virtually died out. Finally, locating historic varieties is rendered more intricate by the fact that many varieties now sold are hybrids. There is a critical need to develop appropriate databases on the types of plantings used in historic times, and current sources of historic plant stock. There is also a strong need to encourage growing the stock itself.

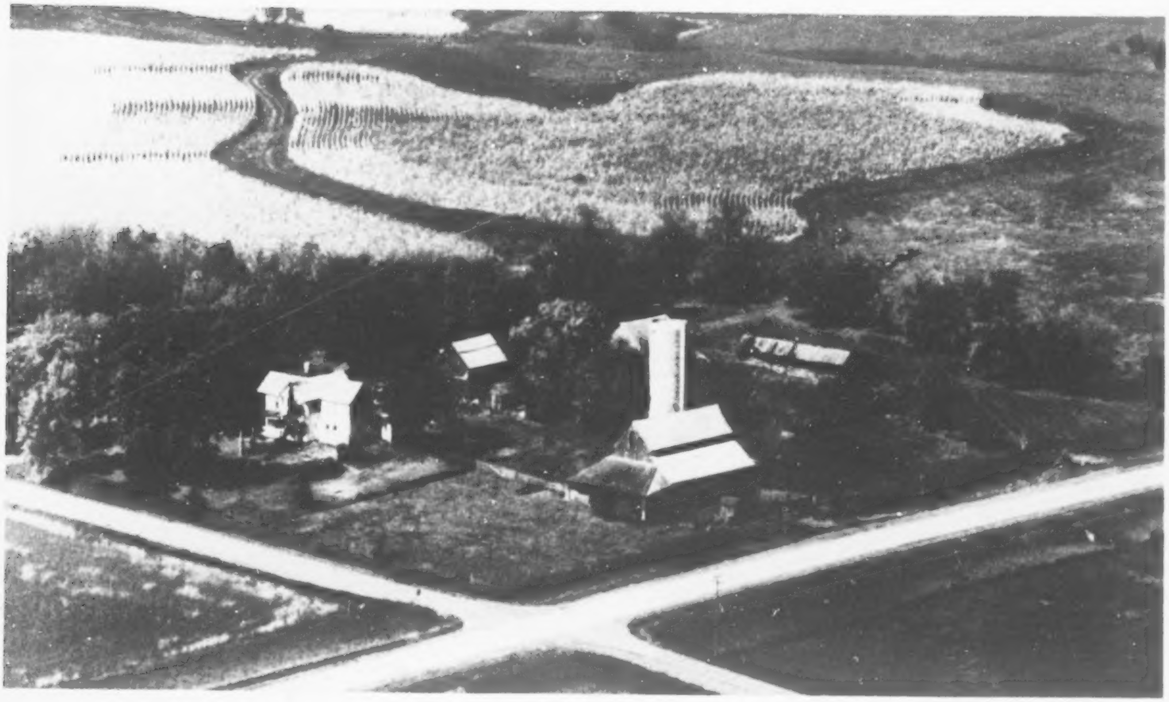


Photo credit: Jon D. Findley

Cultural landscape: the Findley Homestead, Dallas County, Iowa, early 1980s.

7. *Qualitative techniques have an important role in the study of landscapes.*

In analyzing a landscape for such purposes as restoration or park redesign, it is important to be aware of the varied cultural values of the local citizens. Qualitative anthropological or historical techniques, such as interviewing, can be used to understand the values of the different constituencies to relate them to the needs of the entire community. For publicly owned landscapes, such techniques applied in conjunction with those of the landscape architect or designer may significantly enrich the quality of the preservation effort.[84]

8. *Known technologies can be adapted for computer and other applications.*

One of the major tasks facing landscape preservationists is to adapt known technologies to new settings. For example, the use of pinbar registration techniques to produce overlays is well known to architects and landscape architects. Such overlay drafting techniques allow landscape architects to produce different drawings for different landscape components (e.g., structures, walls, trees, and shrubs) and then overlay them on one another. Because they are line drawings, pinbar drawings can easily be digitized for manipulation in a minicomputer or microcomputer using computer-aided design software. They can be used to compare historical drawings with the current condition of the landscape. With the computer, and the appropriate software, it is possible to vary the scale, add and subtract components, and print out the results on a variety of printers.

---

[84] See Scott S. Weinberg, "Environmental Quality Points: A Land Management System," *Landscape Architecture Magazine*, May/June 1985, pp.97-98. For a more complete treatment, see Scott S. Weinberg, "Environmental Quality Points," manuscript, School of Environmental Design, University of Georgia, 1985.

Chapter 4

Restoration, Conservation, Maintenance, and Protection

Contents

Page

Introduction 83

Threats to Cultural Resources 83
  Human Threats 84
  Natural Threats 87

Restoration, Conservation, and Maintenance 89
  Archaeology 92
  Underwater Archaeology 93
  Historic Structures 95
  Landscapes 99

Protection From Deliberate Destruction 101
  Technologies for Security 101
  Law Enforcement 103

Chapter 4

Restoration, Conservation, Maintenance, and Protection

INTRODUCTION

The United States possesses myriad striking, significant prehistoric sites and structures, restored historic houses, public buildings, monuments, bridges, parks, and landscapes. Yet it has lost many more of these important cultural resources, which were just as reflective of significant historic values and became the victims of neglect, deliberate destruction, or of conflicting community values.

Preservation of cultural resources involves restoration, conservation, and maintenance. It may require extraordinary means, such as diverting a streambed to protect properties from severe erosion or law enforcement procedures to apprehend and prosecute looters and vandals. This chapter identifies the primary human and natural threats to cultural resources, and discusses the technologies that can be brought to bear to slow, reduce, or eliminate the damage such threats cause. Although each discipline involved in the preservation process has its own specific interests and requirements for technology, successful long-term cultural resource protection include three basic components, each of which uses a variety of technologies:

1. identification and analysis of the primary threats to cultural resources;
2. evaluation, resolution, or mitigation of specific threats; and
3. public education and involvement.

Each component must be integrated with an overall set of strategies for confronting, managing, and reducing the enormous stresses on America's cultural resource base. Public education, which is an essential part of the Nation's preservation effort, is discussed in chapter 5.

THREATS TO CULTURAL RESOURCES

U.S. cultural resources are subject to a multitude of human and natural stresses (tables 14 and 15). The United States is entering a critical period when the many forces operating to destroy important cultural resources may outweigh the efforts to preserve them for future generations. As one archaeologist noted, "The next generation cannot study or preserve what has already been destroyed."[1] For example, fewer than 10 percent of the known prehistoric Mimbres sites in southwestern New Mexico are still intact. Southeastern Utah has experienced sustained losses of its prehistoric resources. More than 60 percent of the ancient Anasazi sites of the region have been dug for ancient pots, baskets, or other salable items.[2]

Economic pressures in other areas have compelled property owners and real-estate developers to achieve the "highest and best," use of land. That has often meant the most immediately profitable use. Until the first of several preservation tax incentives became available in 1976, the high costs of maintaining historic buildings often meant their demolition and replacement with modern, low maintenance structures that were often out of place in the neighborhood. Urban parks, which contain both landscape and structural elements, are subject to increased visitation, both

---

[1] Charles McGimsey, *Public Archaeology* 3, 1972. See also testimony in hearings on Archaeological Resources Protection Act, 1979.

[2] Carol Ann Bassett, "The Culture Thieves," *Science '86*, July/August 1986, pp. 22-29.

Table 14.—Human-Generated Threats to Cultural Resources[a]

- Agriculture
- Beautification
- Construction
- Demolition
- Drilling
- Energy generation
- Fencing
- Fire
- Firefighting
- Fire rehabilitation
- Grazing
- Mining
- Neglect
- Pollution (air and water)
- Preservation activities
- Recreational technologies (e.g., off-road vehicles, metal detectors, etc.)
- Rehabilitation or retrofitting
- Site compaction
- Timber cutting
- Theft
- Vandalism
- Visitation

SOURCE: Office of Technology Assessment.

Table 15.—Natural Threats to Cultural Resources

- Climate
- Salt air in coastal environments
- Moisture
- Erosion
- Earthquakes
- Floods
- Freeze/thaw cycles
- Subsidence
- Pests
- Blight
- Fire
- Violent storms (tornado, hurricane, etc.)

[a] Not listed in priority order.

minor and major vandalism, and arson. Increased development in urban, suburban, and even rural areas, and (until quite recently) increased oil and gas exploration, have put enormous pressures on what is a finite cultural resource base.

The severity of threats to cultural resources varies depending on the type and the region of the country in which they are found. In the West and Southwest, looting and vandalism are among the most serious threats to archaeological resources. In the Midwest and East, erosion and construction projects tend to cause more damage. Underwater archaeological resources are under severe stress from salvors and uninformed sport divers.

The life expectancy of historic structures, as well as some archaeological sites and landscapes, is threatened by acidic moisture, generated by the pollutions of an urban, industrial society. Inadequate identification, visitation, inadequate managerial/maintenance policies, and malicious destruction are the greatest threats to most landscapes. Far more serious damage is caused to cultural resources by human agency, both intentional and unintentional, than by natural, environmental causes. All of these threats can be significantly reduced by the appropriate application of technology.

Human Threats

Visitation

Over time, visitor amenities, even the wear and tear of visitors' shoes, can do enormous damage to the integrity of any archaeological site, historic structure, or landscape. Managing such stresses to cultural resources requires attention to the varieties of inadvertent harm visitors do and the development of methods to mitigate them. Cultural resource managers must often balance the opposing requirements of encouraging visitors by providing amenities for their safety and comfort, and discouraging them from imposing varieties of inadvertent harm to the resource.

Occasionally, historical accuracy must be sacrificed to protect certain original features, such as flooring and staircases from wear and deterioration caused by heavy visitation.[3]

Photo credit: Hugh C. Miller, National Park Service

Minute Man National Historical Park, Concord, MA. Structures such as the North Bridge are often subject to extremely heavy pedestrian traffic.

---

[3] For example, research revealed that the floors at the Paca House in Annapolis, MD, home of William Paca, one of the signers of the Declaration of Independence, were never covered, painted, or varnished; site interpreters, for authenticity, kept them so. However, heavy visitation is causing some wear and has necessitated the adoption of protective measures.

Photo credit: Lee H. Nelson, National Park Service

Photograph taken in 1965 of carrara marble capital severely eroded by environmental pollutants. Part of the Merchants Exchange, Independence National Historic Park, Philadelphia, PA, erected 1824.

Inadequate Managerial/Maintenance Practices

Managing visitation stresses, maintenance, and restoration requires continuous attention to the needs of the place being preserved. A variety of technologies, including microcomputers, are available to improve such practices and make them more cost-effective.

An Increasingly Acidic Environment

Prehistoric and historic structures and landscapes which were built before the industrial revolution, were created in an environment now altered by acid depositions. In some cases, this threat may override the separate effects of moisture, temperature, and pollutants. The effects of acid precipitation on tangible cultural resources, although experienced worldwide, are not yet well understood. Preservationists cannot wait for society, government, and/or industry to alleviate the problem, but must help to develop the materials, designs, and techniques necessary to withstand an increasingly acidic environment.[4]

Photo credit: Hugh C. Miller, National Park Service

Acid rain monitor at the Eisenhower National Historical Site, part of the Gettysburg National Military Park, Gettysburg, PA.

Looting and Vandalism

Illegal activities, including looting and vandalism, are marked threats to archaeological resources, particularly on public lands in the Southwest and West. As the pressures of urbanization have increased markedly, so have looting and vandalism, in large part because of the high value placed on prehistoric Native American artifacts in national and international art markets.[5] Recent law enforcement investigations reveal that illegal activities on public lands are not solely the work of local individuals who maintain their own collections, but may also be sponsored by private museums, collectors, and dealers.[6] Looters often have the mechanical means and logistical capabilities, including four-wheel drive vehicles, two-way radios, even light planes, helicopters, and other "recreational" equipment to venture far and quickly into the hinterland. They search out, often quite knowledgeably, the sites with the greatest potential for cultural items and indiscriminately rip them apart,[7] sometimes with expensive excavation equipment such as backhoes and bulldozers.

---

[4] M. Del Monte and O. Vittori, "Air Pollution and Stone Decay: The Case of Venice," *Endeavor*, New Series, vol. 9, No. 3, 1985.

[5] Ian Graham, "Looters Rob Our Past," *National Geographic*, April 1986, pp. 452-460; and Gillett G. Griffin, "In Defense of the Collector," *National Geographic*, April 1986, pp. 462-465.

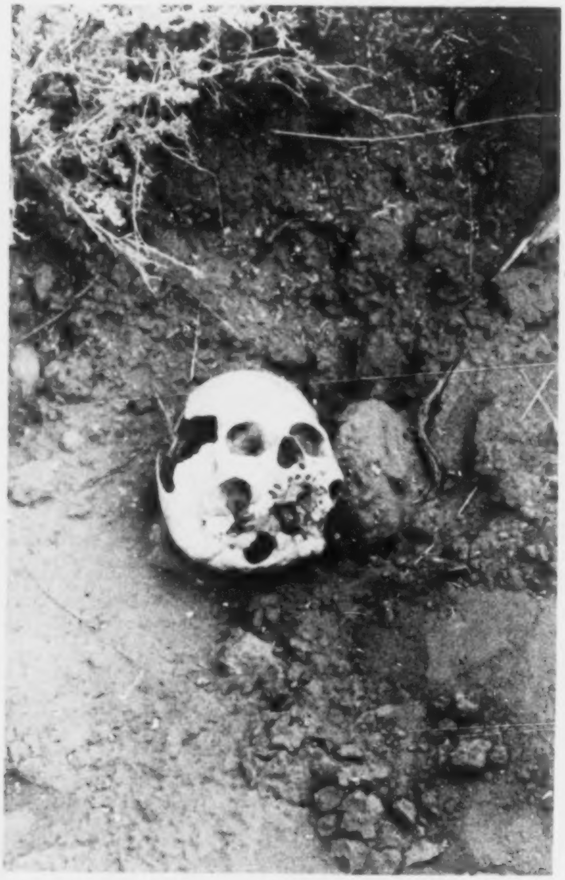


Photo credit: Fred Blackburn, White Mesa Institute, Blanding Utah

Human skull and bones at looted Anasazi burial site in southeastern Utah. Graves are attractive sites for pothunters because they may yield high value artifacts.

Looters search out and destroy Indian burials because they often yield significant artifacts. They may unearth the bones, leaving them for animals and birds, and often break and scatter archaeological items of low economic value. Unfortunately, many of the discarded items can yield more information about past societies than the pots, baskets, and other collectors' items. Yet when ripped from their context, they lose most of their informational content.

Participants in OTA's Workshop on Technologies for the Physical Protection of Prehistoric and Historic Sites expressed deep concern about the destruction of U.S. prehistoric and historic sites that results from national and international trafficking in items stolen from public lands. They noted that the problem is worldwide and will require both domestic and international legal action and cooperation. The original location, or provenience, of most stolen archaeological artifacts is impossible to prove, making it extremely difficult to stem the sale of illegal artifacts.[8] The application of law enforcement technology will only slow down the loss of these items.

The Convention on Cultural Property Implementation Act[9] prohibits importation of stolen cultural property documented as belonging to the inventory of a public monument, museum, or similar institution within a State that is a party to the UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property (see *Chapter 7: Technology and Preservation Policy*). It also restricts archaeological or ethnological materials from other countries on their request and subsequent agreement by the United States.

In the United States, many people who believe that public land should be free to be exploited by individuals, contribute to the protection problem. In many areas, individuals have been collecting from sites on public lands for years.[10]

---

[6] Jim Robbins, "The Great Artifact Grab," *Chicago Tribune Magazine*, Aug. 10, 1986.

[7] Bassett, op. cit.

[8] See Graham, op. cit., for an extremely rare case in which an artifact obtained illegally from Rio Azul in Guatemala was traced to that site as a result of decipherment of the Mayan glyphs inscribed on the piece.

[9] Public Law 97-446.

[10] Although southeastern Utah has been the focus of attention recently (see, for example, Bassett, op. cit.; and Robbins, op. cit., such looting is common in many other States.

Some families in southeastern Utah were even encouraged to do so earlier in the century by museum-based archaeologists and received training in how to dig and what to take out.[11] Some residents in these areas tend to be highly resistive to Federal or even State interference in their "recreational" activities. Inconsistent implementation and enforcement of national laws often increase their frustration and contempt for Federal efforts to stop illegal activities. Yet such attitudes could change if Federal managers maintained closer relationships with State and local agencies and with the general public in local communities. In particular, cooperative educational and research programs conducted on federally managed lands and facilities could be effective.

One author has noted that in addition to research on the methods for protecting cultural resources, more information about the detailed nature of human and natural causes of damage is necessary. She also suggests that behavioral research on vandalism might lead to the development of more effective strategies to protect against this highly destructive threat to U.S. cultural resources. Finally, it is important systematically to study the results of various attempts to protect cultural resources in order to improve on protective design.[12]

Other Human Threats

Although extremely serious, most of the other threats caused by humans, either intentionally or unintentionally, are subject to a variety of Federal controls. Federal and State laws and agency regulations attempt to mitigate the effects of commercial timber cutting, grazing, mining, power generation projects, and oil-and-gas activities on public lands.

Unfortunately, many of these controlled activities increase the access to public lands by pothunters and vandals, by creating new roads and tracks into remote areas. In some cases, individuals engaged in legal pursuits during the day appear to turn to looting and vandalism after work. For example, in areas of southeastern Utah where seismic tests and exploratory drilling for gas and oil have increased recently, so have the reports of damage to sites.[13] Federal managers may also inadvertently contribute to such illegal activities by failing to monitor properly the legal uses of the land.

Human disturbances and technology itself are accelerating the destruction of prehistoric and historic places. For example, off-road recreational vehicles (four-wheel drive and dirt bikes) both increase access to remote areas and tear up the surface of the soil, which then erodes much more readily as a result of wind and rain.[14] In addition, some modern building techniques and materials actually hasten the destruction of historic buildings (see below).

Most public land is subject to a variety of uses, some of which are more destructive than others. In order to make informed decisions concerning the cultural resources under their care, managers need better access to information (see also *Chapter 5: Preservation Information*). They also need to incorporate the results of research on stresses to sites into their management plans. Better information concerning the documented disturbances to sites, structures, and landscapes and mitigation strategies based on such information will also aid managers in presenting their case to others.

Studies on cultural resource protection should be published in journals and other widely distributed sources so they will be available to a wider community.

Natural Threats

Erosion

Erosion from wind and water is a significant natural threat to cultural resources. Both historic and prehistoric settlers have chosen to live as close to water sources as possible, leaving their habitats and associated belongings vulnerable to flood-

---

[11] See Winston B. Hurst, "The Kerr Collection Study: An Archaeological Tale of Woe, and a Study of Burial-Associated Anasazi Ceramics From the Westwater Drainage," Edge of the Cedars Museum, Blanding, UT, in manuscript.

[12] Leslie E. Wildesen, "The Study of Impacts on Archaeological Sites," *Advances in Archaeological Method and Theory* 5 (New York: Academic Press, Inc., 1982), p. 82

[13] OTA site visit, March 1986.

[14] Wildesen, op. cit., p. 75.

Table 16.—Surficial Bank Deterioration Mechanisms

Mechanism/description

Abrasion: Solid materials carried by wind or flowing water collide with an dislodge surface soil particles. Abrasion also occurs during shiting of winter ice covers.

Biological (animals): Examples are bank surface destruction during overgrazing and by animal burrows and trails.

Biological (vegetation): Vegetation normally is conducive to surficial stability; exceptions occur during decay of root material and by tree falls or vegetation patterns that concentrate or cause turbulence in overbank flows or streamflows.

Chemical: Water and acids in water affect cohesive and other types of particle-to-particle bonding; bank material is removed by dissolution.

Debris: Debris gouges, or scrapes material from, bank surfaces as well as causing turbulence and flow concentration.

Flow (water): Soil particle removal by overbank flows and streamflows is a major cause of bank surface deterioration. Quantity of flow, transport capacity, turbulence, secondary currents, and wave action (see description below) contribute to the rate and location of surficial particle removal. Seepage flows remove surface particles as well as contributing to mass bank failures.

Freeze-thaw: Cyclic temperature changes cause fracture due to excessive contraction and expansion and spalling due to successive freezing and thawing of moisture within the bank.

Gravity: The stable slope of a cohesionless bank corresponds to gravitational stability; for steeper slopes, surface particles roll downslope (raveling).

Human actions (on bank): Certain human actions attack the bank—loosening the bank surface material by farming or other mechanized operation is one example. Other actions may influence natural mechanisms—the destruction of a protective vegetation cover by livestock overgrazing is one example. Many actions are possible.

Human actions (stream channel): Examples of direct actions are dredging and sand or gravel mining of channel sediments. Examples of indirect actions are structures and vessel propeller motion that cause turbulence in the streamflow. Many actions are possible.

Ice: Ice contributes to abrasion and debris (see descriptions above). Ice jams restrict a channel and affect stream and overbank flows.

Precipitation: Surficial destruction occurs due to impact by rain or hail as well as during periods of high streamflows and overbank flows.

Waves: Waves due to wind or stream vessel traffic cause surficial deterioration of the bank near the stream water surface.

Wet-dry: Alternate wetting and drying cause stress and chemical effects (see description above) that result in surface soil particle loosening.

Wind: Surface deterioration by wind is normally small as compared with water flow; however, waves due to wind (see description above) contribute to surficial deterioration.

SOURCE: U.S. Army Corps of Engineers, "Final Report to Congress," The Streambank Erosion Control Evaluation and Demonstration Act of 1974, Section 32, Public Law 93-251, Exhibit VII-I.

ing and erosion. One of the most devastating forms of erosion is the failure of streambanks.[15] Table 16 presents a list of the mechanisms leading to streambank erosion.

Moisture

Moisture from the ground and the air in rain and humidity of coastal zones is the most devastating threat to historic structures. Moisture encourages the growth of bacteria and fungi as well as insect infestation. Insects, such as termites and beetles, live in wet wood and consume its cellulose, causing its disintegration. In addition, condensation; plumbing leaks from bathtubs, shower stalls, sinks, and water pipes; and improperly vented appliances can, if not treated, ruin a structure. Residences, still largely of frame construction, might constitute major conservation problems in the future. Poor building practices are leaving wooden structural and exterior members susceptible to moisture.[16] Wooden components of new construction should be properly treated with preservatives, pesticides, and fungicides.

Moisture can also be of significant concern in landscapes. For example, Monk's Mound in Ohio, the largest prehistoric earthen mound north of Mexico, has recently suffered significant damage as a result of rising moisture in the mound. Rising moisture in structures may cause significant damage to stone.[17] It may also adversely affect the preservation of prehistoric and historic rock art[18] (see app. B).

---

[15] "Final Report to Congress, the Streambank Erosion Control Evaluation and Demonstration Act of 1984, Section 32, Public Law 93-251," U.S. Army Corps of Engineers, 1981, for a discussion of some of the major mechanisms and their mitigation.

[16] Harry B. Moore, *Wood Inhabiting Insects in Houses* (Washington, DC: U.S. Department of Agriculture); *Finding and Keeping a Healthy House*, Southern Forest Experiment Station, U.S. Department of Agriculture, Forest Service General Technical Report SO-1, 1973.

[17] E. Winkler, *Stone: Its Properties and Durability in Man's Environment* (New York: Springer-Verlag, 1975).

[18] See the extensive discussion concerning moisture damage to rock art in Constance S. Silver, *The Rock Art of Seminole Canyon State Historical Park: Deterioration and Prospects for Conservation* (Austin, TX: Texas Parks and Wildlife Department, February 1985).

RESTORATION, CONSERVATION, AND MAINTENANCE

Preservation decisions are influenced by two broad considerations. First, at the level of the site, structure, or landscape, cultural resource professionals must generally decide *before* beginning excavation or restoration, on the best conservation plan. At a broader level, managers charged with preserving cultural resources must consider the various goals of preservation and choose appropriate technologies accordingly. Is preservation for future research, for public examination and appreciation, or is it to satisfy certain legal requirements? These considerations affect the management of sites and the expenditure of funds.

Although the preservation of artifacts was not the subject of this assessment, it is nevertheless important to use the best museum technology to preserve the artifacts and other research material that is removed from a property. Some of the technologies used in conservation of artifacts are transferable to sites, structures, and landscapes. However, the applications are quite different. For one thing, artifacts in a museum can be maintained in a controlled environment, modifying light, temperature, and humidity. The much larger scale of sites, structures, and landscapes, and their outdoor settings, bring with them a set of problems not faced in conserving artifacts.[19]

Restoration of a designed landscape often involves rehabilitation of existing elements—pruning and rejuvenation of trees and bushes, dredging of ponds, reconstruction of bridges and walks. It is frequently difficult to find workers who are adequately trained to do such work to the standards required in historic settings. Many of these historic skills are being lost.

Systematic, Long-Term Maintenance

This is one of the most effective methods of slowing deterioration from natural and human agencies, because systematic maintenance (fig. 3) can prevent minor problems from becoming major ones. It is crucial to the conservation of sites and structures, or the elements of a landscape. Quality of maintenance is as important as its regularity.[20]

The designers and builders of many historic landscapes, such as parks and gardens, and historic houses, expected that they would be maintained by adequate numbers of skilled personnel. Today, especially when so many historic properties are owned and maintained by public agencies, the gardeners and other maintenance personnel may not have acquired adequate experience or training. Likewise, contracting stipulations which limit governmental agencies without in-house expertise to accepting the services of lowest bid competitors often result in substandard groundskeeping and maintenance practices.

Because maintenance tends to be labor-intensive, it is important to find ways to reduce the amount of labor required.[21] Maintenance standards and plans must be developed and carried out by managers professionally trained in tending historic properties. As noted below, the increased use of personal computers and specially designed software could be extremely helpful in

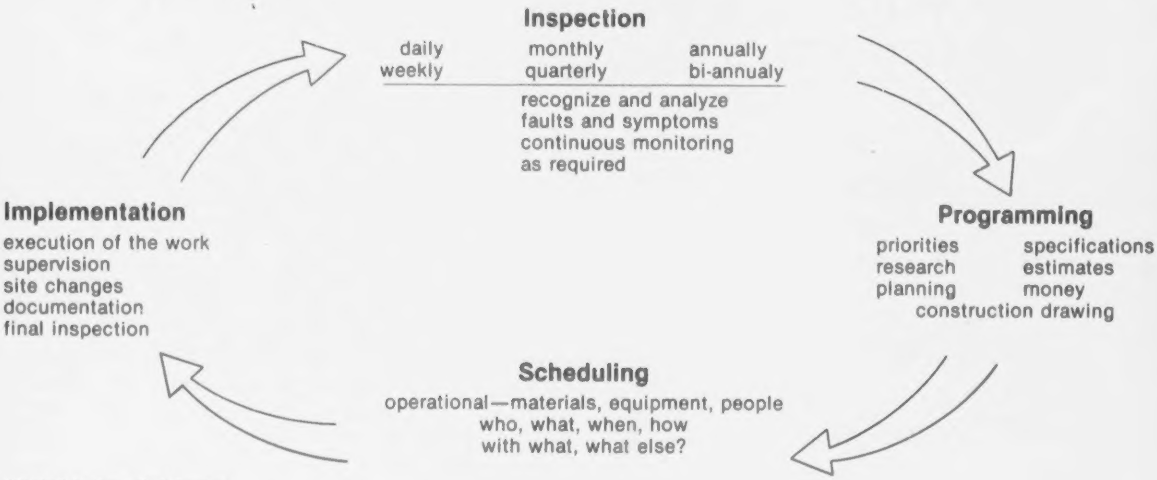
---

[19] A striking example of this is seen in the Maya carvings from Yucatan, Mexico. Maya cities were constructed from limestone, the predominant structural material found in the Yucatan. When, in the course of excavation, the limestone is exposed to the atmosphere, it begins to deteriorate. In many cases, bas-relief carvings exposed at the turn of the century and left onsite have virtually disappeared as a result of constant exposure to the elements. By contrast, those from the same era that were stored in a museum context have been maintained in nearly the same condition in which they were found. (Peter Schmidt, Museo Regional Instituto Nacional Antropologia y Historia, Yucatan, personal communication, 1986.)

[20] *Cyclical Maintenance for Historic Buildings*, J. Henry Chambers, AIA, Interagency Historic Architectural Services Program, Office of Archaeology and Historic Preservation, National Park Service, U.S. Department of the Interior, 1976.

[21] Sleepy Hollow Restorations, in New York State, has reduced its total labor force by developing a program of maintenance that employs two levels of skills. For the basic grounds, the organization uses grounds maintenance employees with only moderate training and skills. It employs college graduates for maintaining the historic gardens. Although the latter command higher salaries, their higher skill and professional interest in historic gardens more than repays the extra investment. In the winter, when maintenance needs are less demanding, these workers carry out research projects that they can apply to improving the historic gardens (e.g., searching out the original garden plantings and determining modern sources). Because such workers generally possess higher communications skills, they are also more effective in communicating required maintenance tasks to outside contractors who trim the large trees and do other specialized work.

Figure 3.—The Maintenance Cycle


Inspection
daily
weekly
monthly
quarterly
annually
bi-annualy
recognize and analyze
faults and symptoms
continuous monitoring
as required
Programming
priorities
research
planning
specifications
estimates
money
construction drawing
Scheduling
operational—materials, equipment, people
who, what, when, how
with what, what else?
Implementation
execution of the work
supervision
site changes
documentation
final inspection

SOURCE: National Park Service.

improving the quality and quantity of maintenance.

Computer Technology

The computer can be an extremely effective tool for predicting possible effects of stresses to an area, planning for the management of maintenance, and enhancing restoration and rehabilitation.

Visitation.—By using a computer to examine the wear patterns caused by known human traffic in given areas, technicians can develop parameters of wear under a variety of conditions. Managers can then ask the computer to simulate the amount of wear different areas of the landscape or structure might sustain as a result of the same amount of traffic. Such information might then be used to predict how best to channel visitor traffic, or which areas might better handle expected park visitors.

Vandalism.—Experience with a particular historic property provides a variety of clues about which parts suffer the greatest risk of vandalism. Such information can be introduced into a computer model that can then be used to predict other areas of great risk from vandalism.

Site Management.—Maintenance planning and management computer software can assist in long-term maintenance. For example, a computerized management plan for a landscape would allow landscape managers to factor in a number of tasks on a cyclical basis. Each different species of tree, shrub, and plant requires a different treatment. Structures such as houses, barns, bridges, pavilions, and interpretive centers require yet a different set of maintenance strategies. The computer allows computation of needed labor resources based on assumptions about maintenance standards and landscape systems, and provides the capacity to match up such needs with available labor. It also enables managers to develop a schedule for maintenance that takes into account the level of education and skills of the maintenance personnel.

Expert systems (see *Chapter 5: Preservation Information*) might be especially effective for designing plans for certain maintenance tasks, especially those that call for highly specific, readily describable techniques.

Computer-Aided Design/Drafting (CADD).—This technology is aiding architects and engineers involved in historic structural restoration and rehabilitation through the Federal Government's historic preservation tax incentives program. Their proposals, supported by drawings, plans, and specifications, must undergo strict assessment for approval by the various design review groups within local preservation committees, State Historic Preservation Offices, and the National Park Service. Drawings and views in perspective are time-consuming and expensive to prepare but constitute important components of the rehabilitation certification process.

CADD software enables designers to complete three-dimensional computer models of the buildings on which they are working, simulating or rotating to any selected view of height or distance, perspective or isometric. All perspectives can be reproduced on a line plotter with or without "hidden" lines. This technology dramatically cuts the time and expense routinely associated with completing hand renderings. For example, CADD allows one practitioner to produce over a dozen drawings in 1 day. Normally, three professionals require 3 days to produce three architectural drawings.[22]

Technologies for Reducing Erosion and Stabilizing Landscapes and Archaeological Sites

As noted earlier, whether it occurs from overflowing streams, the variation in water level of reservoirs, or from wave action, erosion is one of the most serious natural threats to landscapes and to archaeological sites. "The methods available for archaeological site stabilization differ very little from those which have been used for streambank maintenance and general erosion control."[23] Comparatively little research has been carried out on the use of such methods. The following methods, among others, have been used with varying success for site stabilization:

- stone riprap,
- concrete pavement,
- gunite,
- used tire mattresses,
- overplanting,
- driftwood facing,
- sandbags and woven fabric,
- GEOWEB, and
- vegetation around underwater sites.

Although many of the above methods would be unsuitable for the long-term preservation of certain historic landscape features, the use of temporary methods such as the emplacement of certain forms of woven fabric, the use of tire mattresses, or fencing, might prove appropriate in some locations until vegetation growth resumed. The historic earthworks at Fort Foote, MD, were stabilized in this fashion.

Cultural Resources Monitoring

Monitoring of archaeological resources, structures, and landscapes is essential for their efficient management. The specific appropriate technology will differ for each type of cultural resource, but the overall goal is the same—to contribute to the protection of the resource.

As noted in *Chapter 3: Research*, because many archaeological sites are not adequately surveyed, their condition is unknown. Even known sites are seldom monitored periodically. The numbers of sites and sheer size of western landholdings render traditional patrol methods unfeasible. Remote sensing, either from the air or from ground-based cameras, may help to establish a baseline. Once a baseline condition is determined, environmental and other sensors might be used to monitor sites in acute danger, either from natural or human threats (see *Protection From Deliberate Destruction*, in this chapter). Education of tourists and the local population is also an important component in site monitoring (see *Chapter 6: Public Education*). Often volunteer help is crucial in looking after sites, especially those in out-of-the-way or difficult-to-access areas.

In historic structures, it is often necessary to monitor the moisture content or the acidity of the atmosphere in order to determine what treatment may be appropriate. For example, monitoring the condition of roofs or cracks and other signs of movement in masonry walls[24] is important in deciding when additional shoring, repair, or replacement may be necessary.

---

[22] See Karen Kershaw, "Looking Back, a Historical Perspective," *Architectural & Engineering Systems*, March/April 1986, pp. 34-35.

[23] Robert M. Thorne, "Preservation is a Use . . . Experimental Archaeological Site Stabilization in the Tennessee Valley," *Tennessee Valley Authority Publications in Anthropology* 40, 1985.

[24] J. Henry Chambers, *Using Photogrammetry to Monitor Materials Deterioration and Structural Problems in Historic Buildings* (Washington, DC: U.S. Department of the Interior, National Park Service, Preservation Assistance Division, no date).

The following discussion takes up technologies and issues that are more specific to archaeology, historic structures, and prehistoric and historic landscapes. As in earlier chapters, underwater archaeology is broken out for separate treatment because of the highly specific nature of the issues related to it.

Archaeology

Comparatively little work has been done on the conservation of adobe, stone, and wood for archaeological use. However, some of the methods that are being developed specifically for historic structures are applicable to archaeological preservation (see below, discussion of technologies for structures).

Today, the Federal Government seldom restores archaeological sites after excavation, especially in climates where they have deteriorated significantly or disappeared from the surface. Such restorations must generally rely too strongly on conjecture about the site's original form and construction. In addition, they are normally extremely expensive. Instead, the excavation is "backfilled" with earth. Where feasible, sites found above ground are stabilized to prevent them from further deterioration.[25] Prime examples of such sites are the prehistoric Anasazi buildings and villages in Navajo National Monument, or Chaco Canyon National Historical Park.

The National Park Service (NPS) has conducted research on the stabilization of many different kinds of structures in many different soil conditions. Even in relatively narrow regions of the Southwest, the soils originally used as mortar or for adobe vary considerably from place to place. Appropriate mixes of portland cement (for strength and durability) and native soil (for color and elasticity) derive from testing the chemical and physical properties of the soils and developing site-specific mixes.[26] NPS now uses a chemical called Roplex, which it adds to the mortar used for stabilizing the prehistoric sandstone structures in the Southwest. Roplex extends the life of the stabilizing mortar which closely resembles the original mortar in color, texture, and consistency.

Photo credit: Ray A. Williamson

National Park Service employee inserting stabilizing mortar in sandstone wall of Pueblo Bonito, Chaco Canyon National Historical Park, NM.

Not every site can be stabilized with the resources at hand. Some sites have eroded to grade level or are reasonably protected (for example, cliff dwellings) and need little additional stabilization. Because stabilization tends to reduce their archaeological integrity, other sites may lose more of their research value by attempts at stabilizing them than if they were simply left exposed to natural forces of erosion.[27]

---

[25] It is NPS policy to preserve sites as they are when they are inherited by NPS, as opposed to just letting them deteriorate or restoring them.

[26] See, for example, Dennis Fenn and George J. Chambers, *Laboratory Assessment of Soil-Cement Mortars Used in Rehistoric Ruins Stabilization in the National Park Service* (Tucson, AZ: National Park Service Western Archeological Center, January 1978).

[27] For example, at one Anasazi site in southeast Utah, stabilizing mortar appears to have been used to fill in small ports originally in the walls of one structure. OTA site visit, June 1986.

Sites most in need of stabilization are those that are highly exposed to natural and human threats. Such judgments are often made by archaeologists and other cultural resource professionals, few of whom are experienced in analyzing the need for the treatment. Therefore, there is a requirement for basic guidelines and available stabilization options.[28]

There is no known long-term way to stabilize adobe. If left uncovered, it requires periodic maintenance. Therefore NPS has often resorted to building shelters over adobe or mud structures, such as the remains of prehistoric pit houses. Although such measures protect the structures, they are often esthetically displeasing. Much more can and should be learned about how to stabilize existing prehistoric structures. Structural engineers and architects could be of help in investigating better stabilization methods.

Site Burial

After excavation, unless structures are to be stabilized or reconstructed, sites are commonly filled with sterile soil. Such a practice tends to preserve the remaining unexcavated material. Sites have been buried by concrete or asphalt under parking lots, or by rocks, backfill, or water in efforts to save them for future research. However, the long-term effects of various site burial techniques are not well understood and should be studied.[29]

Rock Art Preservation

Prehistoric and historic rock art contain significant cultural information. For example, in California, numerous rock art panels have been studied in efforts to explore the astronomical observations and knowledge of California Indian groups.[30] In New Mexico, careful examination of the distribution of images among rock art panels along the Rio Grande has demonstrated the movement of certain ideas from Mexico into central New Mexico during the 14th and 15th centuries.[31] Relatively little effort has been expended on efforts to preserve these important cultural resources (see app. B).

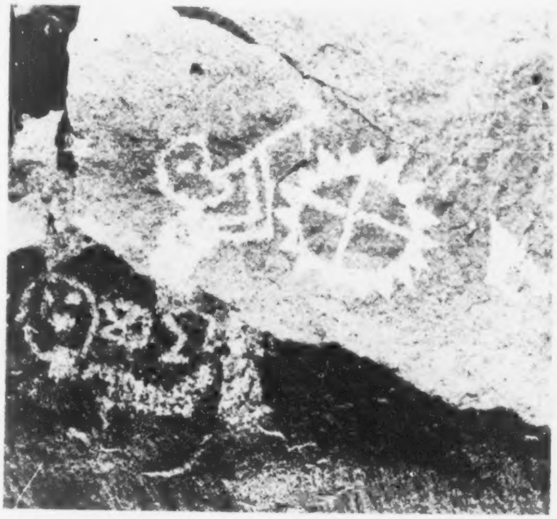


Photo credit: Ray A. Williamson

Ancient Pueblo Indian petroglyph pecked on basalt outcropping south of Santa Fe, NM. The quartered circle to the right of the flute player may represent the sun. The quartered circle is a common rock art motif in the Southwest.

Site Avoidance

In many areas, this is considered the method of choice in preserving archaeological sites. Although in some cases, such a strategy is appropriate and feasible, in many other cases avoiding the site simply puts off for a few years an inevitable conflict with other legitimate uses of the land, and the necessity to make decisions about active preservation.

Underwater Archaeology

Conservation and protection of underwater cultural resources, like other underwater archaeological procedures, tend to be expensive and require extremely specialized knowledge and facilities. Concreted metal, waterlogged wood, and other organic materials such as leather or fab-

---

[28] Jim Trott, National Park Service, personal communication, 1986.

[29] See Thorne, op. cit., for a discussion of several methods of site burial.

[30] Tom Hoskinson and Arlene Benson (eds.), *Earth and Sky: Papers From the Northridge Conference on Archaeoastronomy* (Thousand Oaks, CA: Slow Press, 1985).

[31] Polly Schaafsma, *Indian Rock Art of the Southwest* (Albuquerque: University of New Mexico, 1980).

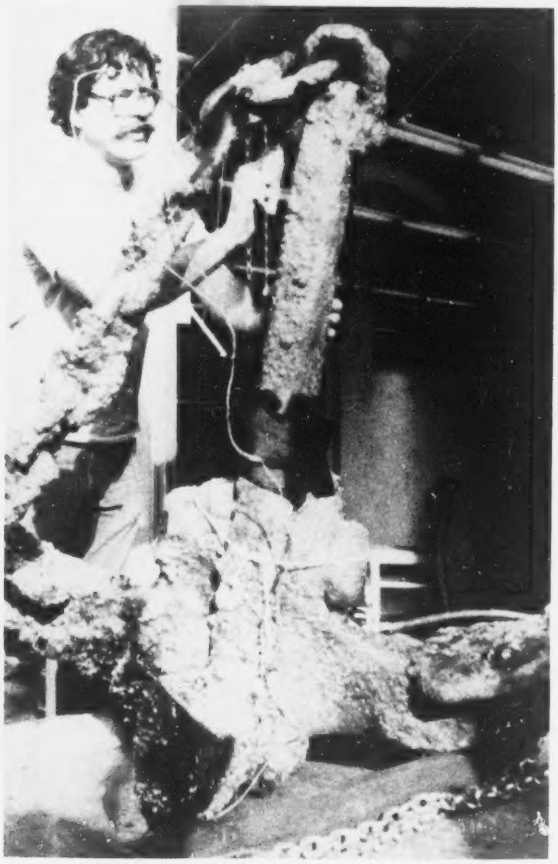


Photo credit: National Oceanographic and Atmospheric Administration

Concreted anchor from the *U.S.S. Monitor* (sunk Dec. 31, 1862). Anchor recovered 1977. Such a large and heavy artifact excavated from underwater constitutes a substantial conservation challenge.

ric begin almost instantaneously to deteriorate when exposed to the open air after having been submerged or buried under sediments. They must be immediately reintroduced into salt or fresh water, via holding tanks, or wet-packed for transport to permanent conservation facilities. Conservation means perpetual maintenance under controlled conditions.

In the United States there is a shortage of conservation facilities as well as a dearth of trained, competent conservation personnel to deal with the ever-increasing numbers of cultural materials being recovered from the deep. In addition, many projects are directed by non-research-oriented organizations and individuals who betray a lack of knowledge of appropriate conservation methods. The following approaches represent the range of conservation treatments available.

Full-Scale Conservation

This approach calls for the stabilization and continuing care of all waterlogged objects taken from underwater, including ship's hulls. This is the most complex and expensive method, but permits scholars and the public to examine thoroughly historic shipbuilding techniques and any culturally significant contents removed from the vessels. This approach necessitates fully staffed conservation facilities with completely controlled environments (humidity, temperature, light, etc.). Conservation processes are time-consuming and tedious and demand a long-term commitment on the part of any agency or institution that assumes the responsibility for applying them.

For example, the Swedish Government has assumed responsibility for the *Wasa,* a well-preserved 17th century Swedish warship, for the past 26 years at a cost of over $20 million. The Mary Rose Trust is in the early stages of conservation of the *Mary Rose,* a 16th century English warship. Harvard University's *Snow Squall* project (located in the Falkland Islands) is currently recovering the first 30 feet of the clipper's hull. Everyone except the trained conservator is a volunteer. The Mariner's Museum in Newport News, Virginia, has taken on the *Ronson Ship* bow in New York City using private funds, in contrast to the other groups which rely largely on public funds.[32]

Even thoroughly stabilized materials remain extremely fragile. Polyethylene glycol is the commonly used wood consolidant and is very costly. However, recent successful experiments using sucrose promise to lower some stabilization costs. Sucrose is very cheap and seems highly stable.[33]

---

[32] Sheli Smith, Mariner's Museum, Newport News, VA, personal communication, 1986.

[33] James M. Parent, "The Conservation of Waterlogged Wood Using Sucrose," *Proceedings of the 14th Conference on Underwater Archaeology*, Calvin Cummings (ed.) (San Marino, CA: Fathom Eight, 1986).

Combined Conservation and Documentation

This approach involves stabilizing all small, portable waterlogged cultural materials and documenting large objects such as the hull; it dramatically reduces conservation costs. Though a significant amount of study is still feasible, some technical knowledge is lost. However, these articles must still be housed in properly staffed conservation facilities. For example, the State of Maine conserved the small artifacts recovered from the *Defence* and made detailed drawings of the hull for only $20,000. The Canadian Government conserved all the small objects from the *San Juan*, molded sections of the hull, and recorded the remaining sections with drawings.[34]

Conservation Through Technology

This technique, as yet unadopted, would involve recording all small artifacts with holographic techniques and all large artifacts through molding and documentation. It would require only holding areas and seasonal conservation staffs. The host institution's commitment would be minimal because its staff can easily transport and store all information. There is a drawback to this approach in that it does not yield any tangible artifacts.

No Action

This approach leaves sites submerged or buried beneath sediments. Deterioration of shipwrecks and other objects is slow and advances in conservation technologies may significantly improve our ability to conserve artifacts taken from a submerged environment. This approach postpones the acquisition of knowledge about a site. Future technologies might enable the analysis and interpretation of certain buried underwater archaeological components in situ. The Turkish Government has left several shipwrecks at Yassi Ada uninvestigated. The State of Maine selected one ship for study after a survey of the entire Penobscot fleet. The Commonwealth of Virginia reburied the Revolutionary War period Cornwallis Cave wreck in anticipation of more information on the scuttled British fleet.

These alternatives represent different emphases in terms of costs, commitment, and conservation facility readiness and capability. Realistic consideration of the pros and cons inherent in each of the above conservation methods should be explicitly reflected in project research plans or archaeological investigations will have only unsatisfactory databases and poorly conserved artifacts.

Historic Structures

The following reflects the current ethic governing the conservation, restoration, and maintenance of historic structures. **"Deteriorated architectural features should be repaired rather than replaced wherever possible. In the event replacement is necessary, the new material should match the material being replaced in composition, design, color, texture, and other visual qualities."**[35]

A variety of techniques and materials can be applied to historic buildings to conserve and maintain materials and systems. They include chemicals to slow the deterioration of glass, wood, and metal; or to clean masonry; techniques for shoring up structurally weakened or unsound buildings; and paints to protect surfaces. The following issues describe some of these technologies and discuss a variety of problems preservationists face in applying them to best effect.

Both the Misapplication and Nonapplication of Existing Technologies

It is important that architects, engineers, and construction personnel be thoroughly trained in traditional building technologies and the causes of structural materials failure. It is essential that they understand the characteristics of the materials to which they are applying protective treatments.

Historic Buildings.—Well-designed old buildings are systems possessing their own metabolic processes, which have achieved a kind of symbiosis with their environment. The history of the Waverly Mansion, a 19th century historic wooden house located in Mississippi, illustrates this point. The house stood vacant for over 50 years. However, because its builder had understood the effects of a hot, humid climate on wood and had designed an adequate ventilation system, the structure, even though uninhabited and unmaintained for so long, exhibited virtually no deterioration of its members.

---

[34] Smith, op. cit.

[35] *The Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* (Washington, DC: Preservation Assistance Division, National Park Service, U.S. Department of the Interior, 1983).

A firm understanding of a structure's site, surroundings, and construction can prevent improper rehabilitative treatments for adaptive use. Louisiana plantation houses, whose living floors were routinely raised about 10 feet from ground level, had first floor masonry walls treated with whitewash, instead of paint, to permit passage of moisture or rising dampness. In some cases, such houses have been rehabilitated by removing the whitewash and replacing it with waterproof paint. However, the paint does not allow sufficient moisture to escape from inside the foundation and hastens the deterioration of the wooden walls and other structural members above.[36]

Modern Buildings.—The need for information on materials failures and remedies is not limited to historic structures. Even many modern buildings from the 1960s and 1970s, as well as some still under construction, exhibit potentially serious flaws that could lead to the failure of certain structural elements, notably, steel shelf or clip angles, and reinforced concrete, today's most prevalent construction material.

Many reflect poor building practices and misunderstanding of existing information; some demonstrate unsuccessful attempts at innovation. Such structures present important lessons to preservationists who can benefit from determining why they are failing, and working closely with trade and professional associations to encourage better comprehension of construction techniques, building materials, and structural systems. These buildings represent prevailing attitudes with regard to contemporary architecture and engineering that tend to place extremely low emphasis on long-term maintenance of reinforced concrete and exposed metal shelf angles. Curtain walls may pose a danger because of failing clip angles. As these buildings age, preservations will confront a growing variety of extremely high-risk building systems.

For example, Alcatraz, formerly a Federal prison, but now a National Historic Landmark, contains a cell-house (1909) constructed of porous reinforced concrete. The local marine aerosol environment is causing its reinforcement rods to corrode. Eventually the exfoliating forces[37] of the rust could cause the entire structure to self-destruct. It constitutes an almost insurmountable conservation problem. Conservationists face similar problems with the huge population of high-risk concrete structures built from the period of World War I to the present day. Besides buildings, such structures include bridge decks, elevated highways, and parking garages.

The National Bureau of Standard's Center for Building Technology, among other research groups, is directing much of its investigation and testing toward reinforced concrete structures. Such activity could significantly affect the direction of both modern and historic reinforced concrete structures design and maintenance, allowing some progress toward managing what looms as an almost intractable conservation challenge.[38]

Historic Masonry Conservation

A major preservation problem relates to the proper identification of the various kinds of deterioration to which historic masonry, which includes every type of natural stone, brick, terra cotta, and adobe is vulnerable. Trapped moisture from the ground or atmosphere, salts, freeze-thaw climatic cycles, pollutants, abrasive cleaning, poor repair, retrofit, and rehabilitation, use of incompatible mortar in repointing, improper bedding, and weathering can pose serious threats

---

[36] Terry L. Amburgey, *Assuring Long Service Life From Wood Structures*, Forest Products Laboratory, Mississippi State University.

[37] The expansion and contraction of trapped moisture, weathering, or chemical action such as the rusting of metal cause exfoliation of stone's surface, that is, flaking, scaling, or peeling in thin layers. See Anne E. Grimmer (compiler), *A Glossary of Historic Masonry Deterioration Problems and Preservation Treatments* (Washington, DC: Preservation Assistance Division, National Park Service, U.S. Department of the Interior, 1984).

[38] *1984 Building Technology Publications*, U.S. Department of Commerce, National Bureau of Standards, Special Publication 457-9 for the range of coverage regarding structural concrete.

Photo credit: Ray A. Williamson

The Reynolds Tavern, Annapolis, MD. This 18th century historic inn, which once served as the Anne Arundel County Library, has been restored and refurbished and is once again being used as an inn.

to historic masonry. Stone's natural inconsistency and layered composition can also hasten its deterioration. Adobe or sun-dried brick, prevalent in the American Southwest, is particularly susceptible to standing rainwater or splash.

How best to treat historic masonry is still highly complex and problemmatical. Many new products introduced into the market, such as moisture-proof coatings and consolidants, touted as cure-alls for the problem of stone deterioration are being developed, principally for new construction. They are, however, often applied inappropriately and unevenly to historic masonry and, in many cases, do substantial, even irreparable damage. Historic masonry requires breathable coatings and consolidants that allow for the migration of moisture and salts through internal spaces, cracks, and cavities to its surface. It is critical that careful testing and monitoring of the effects of new products which could be applied to historic masonry be undertaken. Preservationists firmly believe that historic buildings themselves "should not be viewed as testing grounds for untried methods."[39]

Historic Metals Conservation

Problems associated with the deterioration of metals in America's historic buildings and structures are numerous and complicated. Over a dozen metallic materials are present in this cultural resource base, which includes nails and flashing, bridges, elaborate fences and staircases, fountains, finials, outdoor statues and monuments, structural supports, roofing, and storefronts.[40]

The conservation of zinc, lead, tin, tinplate, copper, bronze, brass, nickel, as well as wrought and cast iron present formidable challenges. Weathering or the result of exposure to the many interactions among chemical and physical elements in the atmosphere may be more damaging to historic metals than the separate effects of individual agents. The combination of humidity, temperature, salts, dirt, grime, acids, and even bird and other animal droppings threatens the integrity of structural as well as decorative or surface metallic materials. Corrosion and degradation are taking place more quickly and extensively, most dramatically because of acid precipitation. Mechanical breakdown seen as fatigue, creep, and abrasion is also a difficult conservation issue. The stress, weakening, deformation, and buckling of metals as a result of of fire have meant the loss of much of the Nation's urban landscape.

The recent restoration of the copper skin of the Statue of Liberty and the replacement of its metal skeleton, its internal support highlighted the damage wrought by the failure of architectural metals to connect. Bolted, riveted, pinned, or welded metal structural members can become disconnected by corrosion, overloading, or fatigue.

Protecting metals in historic structures is ideally realized through long-term, regular maintenance coupled with sound knowledge of the behavior of architectural metals within physical environments. Trapped moisture and abrasive cleaning are as damaging to historic metals as to stone or wood. It is important to find and improve meth-

---

[39] Baird M. Smith, *Moisture Problems in Historic Masonry Walls—Diagnosis and Treatment* (Washington, DC: U.S. Department of the Interior, National Park Service, Preservation Assistance Division, no date).

[40] *Metals in America's Historic Buildings: Uses and Preservation Treatments*, U.S. Department of the Interior, Heritage Conservation and Recreation Service, Technical Preservation Services Division, 1980.

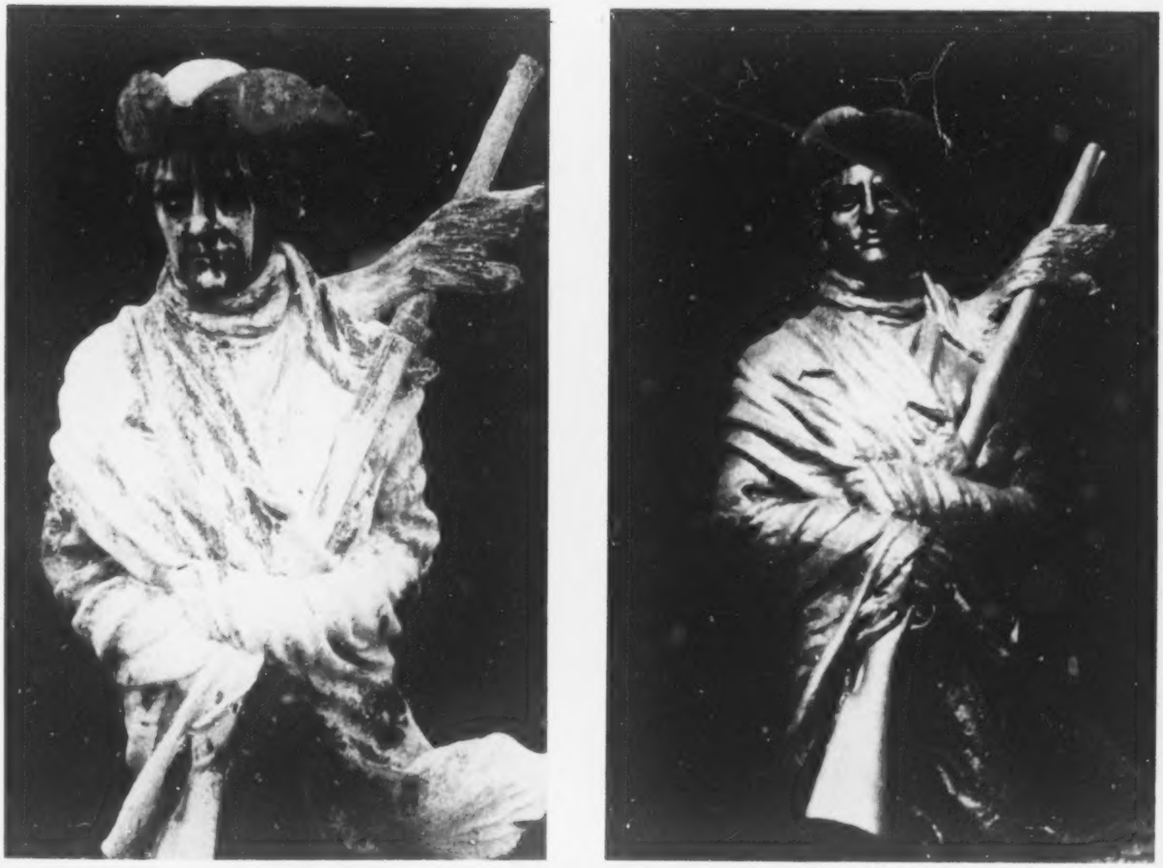


Photo credit: Nicolas Veloz, National Park Service

Photographs of the New Jersey Memorial, Valley Forge, PA showing staining and corrosion of bronze outdoor sculpture and subsequent cleaning. Such discoloration may signify a substantial loss of surface material.

ods for inhibiting and treating corrosion, cleaning surfaces, and to develop appropriate protective metallic, ceramic, or organic coatings. Architects should be fully aware of the load bearing capabilities of structural metals, and proper mechanical repairing strategies, such as splicing, patching, and reinforcing.

Other Major Preservation Research Challenges

Some of the other preservation research challenges are:

- the maintenance and stabilization of fragile historic structures constructed of poor quality materials and never intended to be permanent, such as slave quarters or farm outbuildings.
- the structural integrity of steel frame and curtain walls and unreinforced masonry buildings in earthquake zones. According to structural engineers, unreinforced masonry buildings are among the most dangerous structures during earthquakes. The weight of their exterior walls would mean definite separation from structural framing in the event of tremors.[41] However, they are important cultural resources and account for a sizable portion of the central business dis-

---

[41] *Guidelines for the Evaluation of Historic Unreinforced Brick Masonry Buildings in Earthquake Hazard Zones* (Los Angeles, CA: A.B.K., A Joint Venture, 1986).

tricts and commercial centers in towns throughout the American west. Recommendations for treating them in earthquake zones has ranged from wholesale demolition to a degree of seismic upgrading and retrofit that would be prohibitively expensive and destructive of significant historic fabric.[42]

- the philosophical dilemmas relating to modern building and structural codes, public safety, and politics, a need for a realistic view of "risk and regulation" in historic preservation. Some historic buildings have been so altered to meet modern code requirements that they have been stripped of much of their significance.

Maintenance Information

Detailed information on protective treatments undertaken over the life of a structure is most important to its long-term health. A history of both interior and exterior actions enables informed conservation and maintenance. Past Federal agency maintenance and restoration records should be retained to this end. Federal records managers, many of whom have routinely discarded such records, have only recently recognized their value to preservationists.

Environmental Monitoring

There is need for improved technologies to permit monitoring of the effects of other environmental impacts to which structures are exposed. Monitoring such as that being carried out by the energy industry to determine the effects of sealing structures to prevent loss of heat, and those having been applied in Boston, Massachusetts, to assess changes in groundwater levels reveal much concerning the behavior of buildings and materials.

Building foundations, subway, and underground utility delivery systems such as sewers suffer serious deterioration if groundwater tables are lowered or raised through altered drainage patterns, water removal at new construction sites, or heavy use of deep aquifers. Below the groundwater table, soil is saturated. Untreated wooden piles, used to support the foundations of most of Boston's historic structures, have been decaying as a result of a dropping groundwater table. Such piles are permanent and stable only when they are waterlogged and can repel fungi and dry rot. New construction techniques are reducing and even eliminating the problem. For example, in the Bentonite Slurry Trench method, retaining walls placed around sites prevent the seepage of water into construction areas below the groundwater table and concomitant lowering of the local water level.[43]

Substitute Materials

There is a range of views within preservation concerning the use of substitute materials. In Europe many preservationists advocate that replacement materials be the same as the original. There is such aversion in much of Europe to substitute materials that preservationists reopen old stone and marble quarries to obtain replacement materials from the same sources as the originals. In the United States, however, some building seismic codes require the use of new lightweight substitute materials to replace heavy stone pieces, such as cornices. Other codes allow the use of replacement materials matching the originals only to a specific height, then require the lightweight substitutions beyond the level at which casual observers would not detect the difference.

Landscapes

Conservation and Restoration Decisions

Who determines conservation goals and decides the extent and authenticity of restoration for landscapes? Who decides which public landscape projects receive priority for preservation? These questions are of concern because few landscapes serve only one function. They also are owned or controlled by a wide variety of public and private organizations, or by individuals. Cultural landscapes, especially, generally have multiple owners.

Parks and other public spaces were created as a result of the public need for open space in urban settings. They are used by the public for a variety of recreational, social, and educational activities. Other prehistoric and historic landscapes may be subjected to a variety of stresses as a result of changing land use patterns and development, including mining, drilling, and urbanization. Local residents who wish to use a property may see its value and the goals of preservation in a much different light than preservation professionals. For example, residents might rather build a swimming pool or skating rink in a historic park than maintain a scenic view. Or, the public might complain if grassy areas in a historic battlefield were kept trimmed to historic standards, attributing the higher grass of the historic period to lack of maintenance, rather than historic authenticity.

---

[42] Michael E. Durkin, "Improving Safety in Unreinforced Masonry Buildings," *Ekistics* 51, November/December 1984.

[43] Harl P. Aldrich, Jr., "Preserving the Foundations of Old Buildings''' *Technology and Conservation*, 1979.

Because restoration and conservation are generally expensive and funding for historic preservation increasingly limited, priorities must be set, taking into account local values for current use as well as those of preservation professionals on the significance and degree of deterioration of the landscape. In addition to seeking advice from the local community, the landscape architect and other preservation professionals may have to educate the community about the long-term value of preserving the local landscape (see *Chapter 6: Public Education*).

Landscape Management

Landscapes change so rapidly that management becomes almost as important as restoration. Managing the growth of vegetation is a particularly important issue. For example, rampant species, such as honeysuckle and poison ivy, must be controlled without doing harm to other species or other parts of the environment. There is a strong need to find alternatives to herbicides and pesticides. NPS, for example, has banned the use of both except as a last resort. Such special cases require extensive documentation to support the need for chemicals.

Horticultural or Botanical Technologies

Authentic restoration and conservation of historic landscapes depends on the ability to identify, locate, and use plants appropriate to the historical period of interest. Landscape restorers and managers need inventories of plants grown in a region or area at different periods of history, and sources from which those plants may be obtained. In turn, the restored landscapes themselves can become an important repository for historic species and thereby assist the maintenance of biological diversity within the United States.[44]

The United States is losing important collections of historic plant materials. Yet we often are not fully aware of which plants growing today in historic landscapes are authentic historic materials. England has met such problems in part by insisting that historic gardens and other historic landscapes be replanted using historic species, even if it means that the landscape managers may have to defer certain plantings because plant stock is unavailable at the time they wish to plant.

Although many species may still remain in private collections and smaller commercial nurseries, there is inadequate knowledge of what exists and little control over the disposition of such stock. It may be necessary to establish arboretums designed specifically to save, nurture, and propagate historic species. Because of the regional nature of plant hardiness and adaptability, such arboretums would have to be regional in scope. Sleepy Hollow Restorations has already started searching out and growing historic plants; Monticello recently announced that it was establishing a historic plant center. However, a central clearinghouse for historical horticultural and botanical information, with a computer accessible database, would also be important in increasing our ability to restore, conserve, and maintain historic landscapes.

It is also important to maintain centers where a number of different specialists are working on landscape problems. For example, the National Park Service's National Capitol Regional Center for Urban Ecology maintains a staff of experts in agronomy, urban soils, and urban wildlife.

---

[44] See OTA's background papers entitled *Grassroots Conservation of Biological Diversity in the United States, Background Paper #1, OTA-BP-F-38 (Washington, DC: February 1986; and Assessing Biological Diversity in the United States: Data Considerations,* Background Paper # 2, OTA-BP-F-39 (Washington, DC: March 1986), for a discussion of biological diversity. Both papers are available from the U.S. Government Printing Office, Washington, DC.

PROTECTION FROM DELIBERATE DESTRUCTION

Although education is one of the most effective deterrents to deliberate destruction of cultural resources (see *Chapter 6: Public Education*), a variety of other protective measures are necessary to conserve significant parts of our heritage for future generations to appreciate and learn from.[45]

Technologies for Security

Detailed Inventory of Cultural Resources

Detailed inventory and systematic monitoring of sites are two of the best available protective measures. For other measures to work effectively, agencies need to know what resources they have. Yet, the larger land managing agencies in the west[46] have inventoried relatively few of the archaeological resources, historic structures, and landscapes they manage. In most cases, archaeological sites on public lands are found because development is proposed, land-exchange with a non-Federal institution is initiated, or cases of destruction are discovered.

Further, most agencies have not instituted a program of systematic inspection and routine maintenance of their cultural resources. A number of OTA workshop participants pointed out that Federal agencies tend to respond to threats to cultural resources in reaction to a clear immediate danger rather than planning ahead for potential problems.

Comprehensive, systematic, and complete inventories of all Federal lands would be cost-prohibitive, because of the extensive area involved. However, many areas, more restricted in size, but currently unsurveyed, have high potential for containing important cultural resources. These areas, the likely targets of pothunting and other vandalism, should be better known to agency specialists and managed for their cultural resource values. The appropriate use of predictive locational modeling techniques would be especially useful (see *Chapter 3: Research*). When law enforcement personnel have requested lists of sites that should be monitored, the sites tend to be those that have already sustained damage. Those untouched sites that are unknown to the agency may contain much more information of scientific value than those that have been damaged. Yet, being unknown, they are left vulnerable to potential looters, who find greater time (and the economic incentive) to search them out than do agency archaeologists.

Protective Barriers, Including Fences, Gates, and Boulders To Restrict Access to Sites

The Bureau of Land Management (BLM) has found that fencing and placing signs at Pony Express Stations in western Nevada has virtually eliminated vandalism over the past 8 years. In another example, BLM's installation of fencing surrounding the site of several Anasazi towers overlooking Comb Ridge in southeast Utah seems to have reduced the incidence of vandalism in recent years. However, it also reduces the visual quality of the site.[47] In addition, in certain cases, fencing and signs may attract vandalism by calling attention to the sites, so such methods must be used in ways appropriate to the terrain and the need for protection.

Burying Archaeological Sites

Methods include using top soil, wire mesh, rock asphalt, or concrete to make sites less visible and accessible. Although such methods are often effective in protecting sites from vandals and looters, little research has been done on the effects of site burial on the long-term condition of the buried resource.[48]

---

[45] See especially, Paul R. Nickens, Signa L. Larralde, and Gordon C. Tucker, Jr., "A Survey of Vandalism to Archaeological Resources in Southwestern Colorado," *Bureau of Land Management Cultural Resources Series 11* (Denver, CO: Bureau of Land Management Colorado State Office, 1981); and Dee F. Green and Polly Davis, *Cultural Resources Law Enforcement: An Emerging Science* (Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwest Region, 1981).

[46] Ruthann Knudson, "Contemporary Cultural Resource Management," *American Archaeology Past and Future*, D. Meltzer, D. Fowler, and J. Sabloff (eds.) (Washington, DC: Smithsonian Press, 1986)

[47] OTA site visit, June 1986.

[48] Ibid.

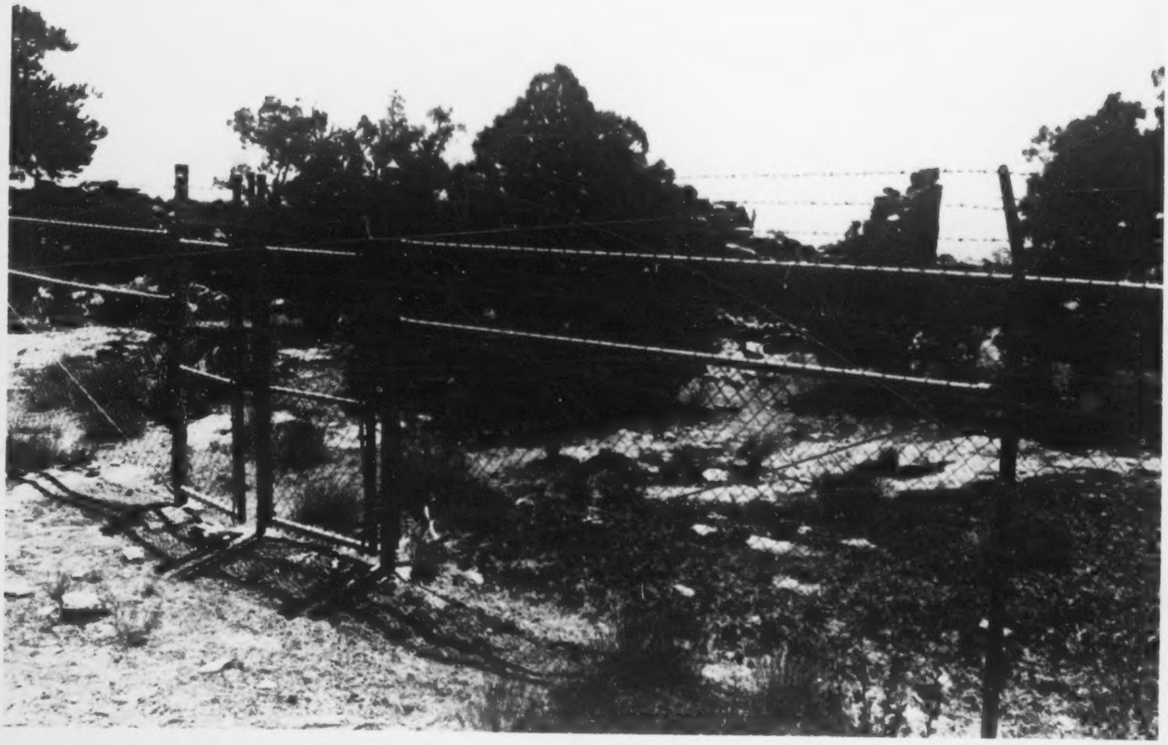


Photo credit: Ray A. Williamson

Example of Bureau of Land Management fencing in southeast Utah. In the background are the remains of several ancient Pueblo Indian towers, constructed of sandstone blocks.

Use of Interpretive Signs

Interpretive signs have the effect of indicating to the visitor that someone cares about the site or structure. In addition to giving some information about the site, such signs may include warnings of penalties for vandalism and theft. New, inexpensive, vandal-resistant materials have enhanced the effectiveness of signs and messages.

Individuals have had good results in protecting sites by placing informal interpretive notes to explain the meaning such sites have to individuals and why they should not be disturbed or damaged. They are discovered, read, and sometimes added to by other visitors.[49] New plastics make possible the development of nearly indestructible tags that could be written on and placed on sites for future visitors.

Propagation of Vegetation, Including Noxious Weeds

Planting or encouraging such weeds as poison ivy and poison oak on site surfaces as well as plants covering underwater sites, keeps most people away, and reduces not only vandalism and looting, but also damage as a result of visitor traffic. This is particularly effective, but only for sites where the environmental conditions will support the growth of such plants. Nettles are effective protectors at Plains Indians' bison jump sites.

Permanently Affixing Large Historic Artifacts or Monuments

Bolting, cementing, or otherwise attaching artifacts or monuments to the Earth tend to be expensive, but such methods are generally effective in preventing theft and major vandalism.

---

[49] Fred Blackburn, White Mesa Institute, personal communication, 1984.

Law Enforcement

Measures such as those just discussed, that either restrict access to sites or warn the potential looter of the legal penalties, have been partially successful in protecting sites. However, determined pothunters or vandals can penetrate nearly any obstacle, making law enforcement measures necessary. In many respects, their methods and rationale are similar to wildlife poachers and they can be apprehended in similar ways. Catching looters and vandals committing a crime is primarily a matter of happenstance, although law enforcement officials have had some limited success using monitoring equipment. The following techniques are used by cultural resource managers and law enforcement officials.

Regular and Irregular Patrols by Agency Personnel

This remains the most effective way to protect cultural resources, though it can be quite expensive, especially over large areas. Evening, weekend, and holiday coverage (when it is generally most necessary), is especially expensive. In addition, law enforcement officers have other duties in addition to protecting cultural resources, and are often assigned other caseload work, which reduces their ability to protect cultural resources.

Informants and Secret Witnesses

Individuals who have witnessed or participated in looting or vandalism may for a variety of reasons be willing to give information to law enforcement officials that leads to convictions on the general charge of destroying government property or for ARPA violations.[50] Informal, noncommercial "pothunters" may be the people most likely to become informants. Obtaining their help will require a change in attitudes among Federal agency officials and archaeologists.[51]

Sting Operations

In certain, well-defined cases, it may be possible to catch looters or middlemen by conducting a "sting" operation for stolen artifacts.

Unarmed Rangers

Prospect Park, in New York, has successfully used unarmed, uniformed rangers to patrol the park. They have the power to issue summonses for "quality of life" violations.[52]

Adopt-a-Site

Local residents are often willing to monitor sites or structures, especially rural ones, on a regular basis and report suspicious activity to law enforcement officials. They become the eyes and ears of the agency in the area. In return, however, such individuals should be kept informed about the results of their work and about agency interest in the sites.

Electronic Monitoring Devices

Much of this technology has been developed for the Immigration and Naturalization Service, the Department of Defense, or to serve other national needs. In the preservation community, the use of these devices is increasing as technologies evolve, and become cheaper and better known to it. Both magnetic and seismic intrusion detectors are available. However, they are still quite expensive, and require trained personnel to maintain and use them. Furthermore, in remote areas, law enforcement officials often cannot reach the site quickly enough to be effective even when intruders have been detected by sensors. In addition, such devices pick up legitimate visitors who are there to sightsee or study the site, as well as those with less benign intentions.

Still, such devices can be effective in providing officials with information concerning patterns and cycles of unwanted intrusions at high value sites, thus enabling them to position personnel nearby at critical times. In other words, they must be used in a coordinated fashion.

---

[50] Archaeological Resources Protection Act of 1979, Public Law 96-95, Secs. 6 and 7.

[51] See, for example, the discussion in Thomas F. King, "The Pothunter as an Ally, Not an Enemy," *Early Man*, Summer 1982, pp. 38-40.

[52] Tupper Thomas and Paul C. Berizzi, "Prospect Park: Rebuilding the Past for the Future," *Parks and Recreation*, June 1985, pp. 24-30.

Remote Cameras

Photographic or video cameras that can survey a scene and can be started by electronic sensors may be extremely effective in gathering needed evidence on looting or vandalism at selected sites. These devices are also expensive and generally vulnerable to destruction by the very looters and vandals they are attempting to monitor.

Listening Devices

Listening devices are available and relatively inexpensive compared to video, yet they are not used because they may violate first amendment rights.

Alarm Systems

Both fire alarm and break-in alarm systems are generally used in historic structures. To be most effective, they must be simple to use and to maintain. Otherwise, they may be ignored or improperly used.

Chapter 5

Preservation Information

Contents

Page

Introduction 107

Technologies for Archival Research 107
  Issues 109

Technologies for Preservation Information 109
  Optical Disk Systems 109
  Computers 110

Databases 111

Issues 115
  Technologies for Conserving Records 116
  Document Preservation and Copying 117
  Maintaining Noncomputerized Information 118
  Information on Underwater Archaeological Resources and Technology 118

Table

Table No. *Page*

17. Preservation Information 107

Chapter 5

Preservation Information

INTRODUCTION

The preservation of prehistoric and historic cultural resources depends substantially on the use of historical records and technical information that exist in a variety of forms and are stored and maintained in a variety of places. Decisions concerning the restoration and maintenance of historic landscapes are highly dependent on historical maps and landscape designs. Historians and architectural historians depend on drawings, historic photographs, and written records for their research. Archaeologists may find ethnologies, historic maps, or even insurance records[1] useful in their investigations. The Library of Congress (LOC); The National Archives and Records Administration (NARA); The National Park Service (NPS); The Smithsonian Institution; The National Technical Information Service; and other Federal, State, and local agencies acquire and maintain a wide variety of information on prehistoric and historic sites, structures, and landscapes.

One of the most critical problems confronting historic preservation involves the storage, retrieval, and dissemination of technical and other information on prehistoric and historic sites, structures, and landscapes (table 17). How all of these varied materials are conserved and made available for research is of vital importance.

Table 17.—Preservation Information

- books—histories, novels, poems, etc.
- charts
- catalogs
- newspapers, journals, magazines
- construction/repair/maintenance reports
- field records
- documents—letters, diaries, administrative correspondence, tax records, insurance records, deeds, wills, etc.
- architectural/landscape specifications/drawings/blueprints
- pattern books
- electronic and video recordings.
- optical disks
- films
- maps
- plats
- photographs—aerial, terrestrial
- machine-readable records—tapes, computer disks, microfiche, phonographs
- analog/digital remote sensing data
- artwork—paintings, drawings, prints
- recorded and sheet music

SOURCE: Office of Technology Assessment.

Much of the information of interest to historic preservationists is housed in Federal agencies. Out-of-date Federal records, according to the various statutes and public laws[2] affecting the disposition of Federal agency records, are accessioned by NARA. However, the reality of records management by the Federal Government does not necessarily reflect adherence to these laws. In another context, it was noted that, "the United States is in danger of losing its memory."[3] To help prevent the loss of preservation's memory, agencies should make every effort to keep track of their active records and to transfer their retired records in a timely manner to the National Archives.

---

[1] See William M. Kelso, "Mulberry Row: Slave Life at Thomas Jefferson's Monticello," *Archaeology* 39, 1986, pp. 28-35, for an account of the use of historical records in an archaeological investigation. See also Theodore J. Karamanski, "Logging, History, and the National Forests: A Case Study of Cultural Resource Management," *Public Historian* 7, 1985, pp. 27-40.

[2] 44 U.S.C. 2101-2114, 2901-2909, 3103-3107, 3301-3314; U.S.C. 2071; Public Law 95-416 and Public Law 95-440.

[3] *Report of the Committee on the Records of Government*, Washington, DC, March 1985.

TECHNOLOGIES FOR ARCHIVAL RESEARCH

Once the records are transferred, however, the most important point to understand about archival records is that in many cases they are not organized by subject like library books. Government records housed in the NARA system (which includes regional branches throughout the country) are organized by the principle of provenance, which means that records created by one government unit are not mixed with others. For example, the files of materials created by the Bureau of Indian Affairs are not mixed with the records originated by the War Relocation Authority, even if the subject (Indian removals during World War II) is the same.

Provenance, however, may be supplemented by a subject system because of technological developments. That happens, for example, in national networks in which any number of institutions (as diverse as LOC and NARA, and the universities Stanford, Harvard, Cornell, Wisconsin, and Michigan on one system) add descriptions of their holdings with any number of keywords. These can combine books and archival records. As archivists rethink their collections for purposes of adding the information to these databases, they are also rethinking descriptive practices and supplementing the principle of provenance. In addition to the collections of documents in archives and manuscripts in libraries, such other materials as collections of maps, films, photographs, and architectural drawings can be described through this method. This can provide a finding aid to make a rapid scan of the content and location of the collections at the start of a project.

Developments in optical character readers have potential for archival use. One, tested recently using the 19th century ledgers of the Bureau of Indian Affairs, can recognize handwriting. It was apparently 92 percent accurate before corrections were made.[4] Optical disk storage gives a clearer, higher resolution version of materials than can microfilm technology, and it is faster and more efficient to use and to store than current forms.

In addition to developing more efficient ways to locate and house research materials for individual projects, technology allows access to a wider range of materials. Some projects have developed databases such as the Documentary Relations of the Southwest (DRSW) project based at the Arizona State Museum in Tucson. With documents running chronologically from 1520 to 1820, and a geographical area defined as approximating the boundaries of colonial New Spain, the research tools created include a master index and separate biographical and geographic files. BIOFILE Southwest consists of a master list and additional indexes of relatives and household members; occupations and titles; and a BIODEX which indexes over 44,000 names culled from secondary sources. While the collection is not yet definitive and comprehensive, it makes research in materials relating to colonial New Spain easier.

In addition, some projects are considering ways to use location information. With a set of coordinates that pertain to a site, or a region, or other physical location, the researcher can receive a print-out of library and archival materials related to that physical spot. GEOFILE Southwest is an alphabetical gazeteer of almost 65,000 Southwest place names that is correlated with three separate geographical references. Research for projects that cover a wide geographical area would clearly be more practical with this means of accessing information.

The need to establish intellectual control over materials crucial to research projects has led to developments of importance to preservationists. Archivists are developing record exchange formats to be used for individual projects to standardize (as far as that is possible) the documentary research for resource investigations.

Such developments make the process of organizing a research project more efficient. Being able to handle information electronically has also changed the materials to be used for research. For example, the Afro-American Communities Project housed in the Smithsonian Institution's National Museum of American History has used varied sorts of local civic, economic and religious records, as well as newspapers, private writings, and national surveys such as census records to trace the migration, living, and working patterns of free black people before the Civil War in major American cities like Boston, Cincinnati, and San Francisco. Combined with archaeological information, the project explores internal household activities such as food consumption. Furniture inventories and similar lists of household goods help to re-create a picture of everyday life in a complex black community.

---

[4] Thomas E. Weir, Jr., National Archives and Records Administration, personal communication, 1983.

Issues

Storage of databases that arise from individual projects.—It will be important to develop some means of keeping track of these databases, like the "grey literature" of archaeology, because such a record might prevent the re-doing of research. On the other hand, the materials so accumulated might be useful only rarely.

Only a few institutions may receive the bulk of research attention.—The possibility that institutions with the money to be involved in these systems may receive the bulk of the research attention because their holdings are more accessible and thus easier to use than those not yet on the system, could discriminate against groups whose historical records lie in smaller depositories.

It will be important to develop means of paying for the development of finding aids and databases.—Developing the finding aids and databanks from the archives and manuscript depositories is labor intensive. It will require the development of new sources of funding.

TECHNOLOGIES FOR PRESERVATION INFORMATION

This section identifies and discusses several important technologies or classes of technologies related to preservation information.

Optical Disk Systems

Optical disk systems offer a number of features well suited for storing, retrieving and manipulating preservation information. They are capable of storing audio, full motion video, still images, and text. Data for microcomputers can now be stored digitally on optical disks; such disks can store up to 1 billion bytes of data. Disks can be quickly and easily searched; any information on a single disk can be recovered within 1 second. Optical disk technology also promises to lower the cost of recording and accessing data dramatically. However, it raises important questions concerning longevity (see section below "Longevity of records stored on new technologies").

For example, the Connecticut State Department of Transportation recently recorded images of much of its highway system on laser disks. With merely 15 disks the Department has replaced an entire roomful of film cabinets.[5]

The Massachusetts Institute of Technology has pioneered the use of the technology for surveying towns.[6] With interactive optical disks they have:

- recorded scenes of the same building in different seasons, along with contemporary and historic views, designing a sequence that allows the investigator to pursue various levels of research detail and, in effect, enter a building to study its functions;
- allowed the investigator to switch back and forth between still and live action images; and
- allowed the investigator to move down a street and choose different routes with no perceptible interruption in the flow of images.

This technology is promising not only for survey but training as well. The Department of Defense (DOD) uses this new technology to teach electrical and mechanical processes too complex to be explained via the typical training manual, such as those for new tanks or aircraft. A mixture of text, still, and action imagery allows students, through a series of procedures, to learn the consequences of both wrong and right decisions.

---

[5] John Myers, Georgia Institute of Technology, personal communication, 1986.

[6] Andrew Lippman, "An Application of the Optical Videodisc to Computer Graphics," *Proceedings of the SIGGRAPH '80 Seventh Annual Conference on Computer Graphics and Interactive Techniques*, Seattle, WA, July 1980.

For the purposes of historic preservation, an optical disk training package on cleaning building exteriors could present a menu containing certain treatment selections. The program could then demonstrate the results of those selections. The effects of destructive applications such as sand blasting or inappropriate chemical cleaning could be revealed and emphasized immediately through a time-lapse sequence, showing how a building would look after 1 year, 5 years, etc.

An optical disk the size of a long-playing record holds approximately 54,000 single images on each side; the master disk costs around $2,500 per side to make. Each disk can be copied for only about $15.00 (±20 percent) and can thus be widely distributed. Although optical disks have markedly decreased the time consumed in accessing information, overall costs are still high. Mastering a disk does not include the extensive labor required to accumulate the images for the disk, nor any supportive text. It also does not include disk preparation, labeling, or cataloguing. These costs can be expected to decrease rapidly as production volume increases.

Computers

Computers have become an important part of historical research. The proliferation of minicomputers and microcomputers has made it possible for the preservation community to record, store, retrieve, and manipulate a wide variety of data on prehistoric and historic sites, structures, and landscapes. Although computer technology is still undergoing rapid change, it has already become more powerful, less expensive, and available to more people in the workplace and at home than it was just a few years ago. Yet, preservationists have only recently begun to exploit computer technology in acquiring and disseminating information. Primary constraints to widespread use by preservation professionals include high costs of hardware and data entry, which is extremely time-consuming and labor-intensive; lack of standards for documenting historic preservation information; inadequate coordination among Federal, State, and local agencies in harnessing computer technology; and lack of familiarity with the technology itself.

Networks

Preservation professionals in the universities tend to make little use of the available university mainframe networks such as BITNET and ARPANET. Yet, they can be sources of free information and software. Few preservation professionals are mainframe computer users and the network systems are relatively new.

For micro computer users, commercial information services such as Compuserve and Dialog are available. However, only a few of the major publications in the several preservation disciplines are available in commercial bibliographic data bases.

Expert Systems

Technological development has not only increased the computer's capacity for receiving, storing, and presenting enormous amounts of data; it has also resulted in the application of expert or knowledge-based sytems. Expert systems are a subset of " 'artificial intelligence,' a term that has historically been applied to a wide variety of research areas that, roughly speaking, are concerned with extending the ability of the computer to do tasks that resemble those performed by human beings."[7] These systems are developed to aid decisionmaking in certain kinds of practical tasks such as diagnosing diseases, repairing mechanical systems, or analyzing molecular structure.

Expert systems store the inferences governing rules, steps, or procedures which model or describe the way experts approach tasks. Expert systems interact with users to solve problems by asking a series of questions and suggesting possible courses of action. Although currently expert systems can be designed for use within rather narrow specialties, they offer greater promise than any automated technology thus far for giving meaning to stored information. **This capability could be very important in historic preservation because of the scarcity of knowledge and the**

---

[7] See U.S. Congress, Office of Technology Assessment, *Information Technology: R&D Critical Trends and Issues,* OTA-CIT-268 (Washington, DC: U.S. Government Printing Office, February 1985).

intense demand for information, decisions, and judgements in dealing with materials and structures.[8] Expert systems can also be designed for archival records retrieval and may eventually change the way preservation professionals collect and process data.

Such systems may be useful for problems that are extremely well-defined, or bounded, such as the choices of specific technologies for conserving stone or wood. However, most other research problems in preservation are so difficult to limit that they are unlikely to yield to expert systems.

DATABASES

One of the most significant advances of the last decade in the development of databases is the invention and proliferation of inexpensive microcomputers and their associated software. As they have become increasingly more capable and cheaper to acquire, individuals and small institutions can develop their own powerful databases, and communicate, by telephone and modem, with other databases around the world.

The generation of databases is one of the most critical aspects of computer use for information storage and retrieval. The simplest and most important database for all intellectual activity is bibliographic. Therefore, it is necessary to develop as complete a bibliographic database as possible. Databases are crucial to the efficient use of information. The following sections list some of the important preservation databases known to OTA. They are representative and not meant to be inclusive.

Federal Preservation Databases

For the most part the regional offices of the various land managing agencies have traditionally operated with great autonomy. This autonomy has resulted in a fragmented approach to applying computer technology to historic preservation information. Regional offices would benefit greatly from compatible hardware, software, and standardized formats.

The National Park Service.—The National Register of Historic Places's National Register Information System has been operational since May 1984. It contains information on over 45,000 prehistoric and historic structures, objects, and sites in the United States, both listed and determined eligible for listing.

The Computers Committee of the National Conference of State Historic Preservation Officers has, since 1983, attempted to standardize certain elements of the State-Federal preservation program. The committee's effort will link individual State computer databases with the National Register Information System and aid those preservation offices in the early phases of computerization. This initiative will greatly facilitate, with the adoption of common data fields, each preservation office's ability to engage in information exchanges and cooperative studies. In addition, it will give greater uniformity to the year-end reports the State offices must submit to NPS in order to receive Federal historic preservation funds.

National Archeological Database.—This database will store data on archaeological contract work. Most of this is composed of the so-called "grey" literature and includes approximately 150,000 contract reports on archaeological survey, salvage, and other work.

A Proposed Database of Databases.—NPS is developing an index of cultural program databases within its Washington, DC, office. The base will provide data fields and descriptions. NPS will make its databases available through the State preservation offices to any legitimate user. NPS will therefore depend on State preservation offices to screen potential users.

---

[8] See NBSIR 85-3186, *Development of Durcon, An Expert System for Durable Concrete: Part 1,* James R. Clifton, Bhalchandra C. Oltikar, and Steven K. Johnson, U.S. Department of Commerce, National Bureau of Standards, Gaithersburg, MD, July 1985. This is the first of a series of four progress reports to be completed on recommendations for constituents for durable concrete. The reports will address the problems (freeze-thaw, sulphate effects, reinforcing steel corrosion, and cement/aggregate interactions) associated with concrete, the most widely used man-made construction material.

Box B.—The National Register of Historic Places, U.S. Department of the Interior National Park Service

The National Register of Historic Places is the official list of the Nation's cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archaeological resources. The National Register is administered by the National Park Service under the Secretary of the Interior. Properties listed in the National Register include districts, sites, buildings, structures and objects that are significant in American history, architecture, archaeology, engineering, and culture. These resources contribute to an understanding of the historical and cultural foundations of the Nation.

The National Register includes:

- all historic areas in the National Park System;
- National Historic Landmarks which have been designated by the Secretary of the Interior for their significance to all Americans; and
- properties significant to the Nation, State, or community which have been nominated by the States, Federal agencies and others and have been approved by the National Park Service.

The National Register of Historic Places

Listing in the National Register has the following results which assist in preserving historic properties:

- Recognition that a property is of significance to the Nation, the State or the community.
- Consideration in the planning for Federal or federally assisted projects.
- Eligibility for Federal tax benefits.
- Consideration in the decision to issue a surface coal mining permit.
- Qualification for Federal assistance for historic preservation, when funds are available.

National Register properties are distinguished by having been documented and evaluated according to uniform standards. The Secretary of the Interior's National Register criteria for evaluation and documentation standards are used by every State and Territory and by Federal agencies to identify important historic and archaeological properties worthy of preservation and consideration in making planning and development decisions.

The National Register program provides Federal, State, and local governments and the general public the following:

- National recognition of the value of historic properties individually and collectively to the Nation.
- Eligibility for Federal tax incentives and other preservation assistance.
- Assistance in cultural resource planning.

SOURCE: National Park Service.

The Cultural Resources Management Bibliography (CRBIB) and The List of Classified Structures (LCS).—Both databases contain evaluated information concerning properties under NPS management. Significant archaeological sites as well as prehistoric and historic structures are listed. The first base contains 23,000 entries, the second, 7,000. These computerized lists are intended as planning aids to National Park Service managers and cultural resource professionals throughout the system and as information sources to the general public.

The List of Classified Structures contains data relative to each property's name, level of significance (national, State, or local), National Register status, location, type or function, material composition, age, physical condition, level of conservation and maintenance required, level of documentation, kinds and severity of impacts and stresses, etc.[9]

---

[9] "User Manual for Cultural Resource Databases, List of Classified Structures Cultural Resources Management Bibliography," Alicia Weber (compiler), Park Historic Architecture Division, August 1986 (draft).

The Cultural Resources Management Bibliography contains comprehensive information relative to the kinds of publication, report, or study carried out on each property.

The Historic American Building Survey/Historic American Engineering Record (HABS/HAER) Computerization Program.—Data on historic sites and structures delineated through the National Park Service's Historic American Buildings Survey (HABS) and Historic American Engineering Record (HAER) are available via computer from both the NPS and the LOC. Measured drawings, photographs and supporting research information compiled by HABS from 1933 to 1982 and HAER from 1969 to 1985 cover thousands of properties—over 16,000 buildings and 1,200 sites of significance in the Nation's industrial and technological development. Entries are listed alphabetically by State code and numerically by county code. They provide property or site location, HABS or HAER number, quantities of drawings, photographs, and supporting research information. In addition, entries indicate where all documentation is housed, either permanently within LOC or temporarily within NPS, in preparation for eventual transmittal to the Library. The computer index is accessible at terminals located within the Library and the HABS/HAER office within NPS.

The Census of Treated Historic Masonry Buildings to Maintain Long-Term Records on Treatments to Historic Buildings.—With the Center for Architectural Conservation, Georgia Institute of Technology, the Service is developing microcomputer programs in order to create accessible microcomputer databases on such subjects as laboratories, products, training, organizations, special collections, consultants, and print and nonprint material.

The Intermountain Antiquities Computer System (IMACS).—Begun 11 years ago by the U.S. Forest Service, this cooperative cultural resource data management system serves its Intermountain Region, one of nine within the system, as well as the Bureau of Land Management, and the State Historic Preservation Offices of Utah, Nevada, Idaho, and Wyoming. It contains information on all classes of cultural resources. It provides locational and conditional information on structures and archaeological sites, their age, type or function, cultural affiliation, and the environmental attributes of the areas within which they are situated. It is accessible accessible not only via mainframe but mini- and micro-computer systems and provides data not only on public lands but private holdings as well.

The Library of Congress (LOC)

The National Union Index to Architectural Records.—This database can be accessed by the name of the architectural firm; partner; name or location of a building or structure; as well as by building type. Also, LOC's Optical Disk Pilot Program represents an attempt to identify costs, benefits, strengths, and shortcomings associated with this technology for storage and retrieval of the Library's collections. The technology holds great promise in addressing problems concerned with access to fragile, rare, and deteriorating collections materials.

The database for the National Union Index to Architectural Records is maintained by Cooperative Preservation of Architectural Records (COPAR). COPAR was established to encourage the collection, maintenance, and interpretation of records threatened with loss or destruction, and to serve as a national and international clearinghouse of information on the location, preservation, and cataloging of these documents. To achieve these goals COPAR offers guidelines for the establishment of local and State groups, provides technical assistance and information to professionals and the general public. In addition, COPAR maintains the data for a national union catalog of architectural records, and it accepts and provides information about them.

Non-Federal Databases

State Databases.—All States via the State Historic Preservation Offices maintain the most systematic lists on archaeological sites and prehistoric and historic structures within the States and Territories. OTA queried each State Historic Preservation Officer, requesting descriptions of new technologies being applied to locating, analyzing, and protecting their cultural resources. The letters specifically requested information on historic preservation computer database development and whether the SHPOs take part in other databases on the National or State level. Sixteen States responded to OTA's inquiry. Replies revealed that some States have experienced easier access to the technology than others and have, therefore, made more progress in entering locational and descriptive information on their prehistoric and historic structures and archaeological sites. For the most part, the State Historic Preservation Offices do not take part in other State or in National databases, but look forward to gaining access to the National Register Information System. On-line access to the National Register Information System will begin in 1987 on a trial basis.

The University of Maryland's Architecture and Engineering Performance Information Center.—It has started to track structural failures in buildings. Although not specifically preservation oriented, it might serve as a model for preservation or contain useful information on reasons for failures in historic buildings.

The Getty Museum.—As part of its program to develop an art and architectural information thesaurus, the Getty Museum is attempting to standardize some of the language used in computer programs. At present, the research and architecture sections are the most complete, but not yet available. Over 9,000 entries are specific to architecture. Another 4,000 entries are terms shared by the fine and decorative arts. The Getty Museum is also incorporating the database compiled by the Canadian Conservation Institute.

The Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM).—This database, residing in Rome, considered the most complete bibliographic database in the preservation field, is now on a mainframe computer and also available in printed form. ICCROM has embarked on a project to convert it to micro computer for easier access. At present, it is virtually inaccessible by outside computers.

The National Association of Corrosion Engineers/National Bureau of Standards.—This corrosion database is a collaborative program to collect, evaluate, and disseminate corrosion data. It includes a user-friendly computer database of evaluated data on the rate and stability of metallic materials.

Underwater Archaeological Databases

Of all cultural resources areas, underwater and maritime materials are the least inventoried and stored in computer. The Texas Antiquities Commission has begun a computerized shipwreck reference file, which could serve as a model to States that have not yet begun their own maritime and submerged sites surveys. It is based on information culled from both historic and contemporary sources such as maps and field reports. The file represents an effort to determine more effectively where likely unidentified wrecks might be situated and to aid research. Not all wrecks indicated have been located because not all historic references are totally reliable. However, this resource file allows the State to demonstrate the possible existence of a historic shipwreck within a particular geographical area. The file often helps justify the employment of nondestructive remote sensing surveys before a potentially destructive activity, such as dredging or harbor facility expansion begins.

Since 1972, over 1,000 shipwrecks have been listed, of which approximately one-half have been determined historic. Recently the Commission elected to augment the file with maps and navigation charts. The States, because they have not made much headway in applying computer technology to maritime inventories, can initially achieve a substantial degree of consistency by working together in developing compatible databases and efficient computer networks.[10]

Underwater archaeologists and maritime preservationists could make excellent use of computer technologies to establish as quickly as possible a mechanism that permits the ongoing revision of statistics on the condition of all classes of known submerged cultural resources. Such statistics can dramatically and meaningfully convey to the public a sense of the relative health of such resources. At present, there is no broad-based, consistent quantification of the rate of loss of submerged cultural resources.

---

[10] J. Barto Arnold, III, "Underwater Cultural Resource Management: The Computerized Shipwreck Reference File," *Underwater Archaeology: The Proceedings of the the Eleventh Conference on Underwater Archaeology*, Calvin R. Cummings (ed.) (San Marino, CA: Fathom Eight, 1982), pp. 85-95.

Landscape Databases

The preservation community should support efforts of the Library of Congress; the National Archives; and other Federal, State, and local archives to identify and maintain records of landscapes because, **at present, no national landscapes database exists. A first important step will be to create a database listing deposits of records and collections throughout the country.** The following databases contain some information about prehistoric and historic landscapes.

The Library of Congress.—Its National Union Index to Architectural Records (see above) contains information about landscapes.

The National Park Service (BIBSCAPE).—This is a database of all the landscapes within the national parks. It is separate from the LIST OF CLASSIFIED STRUCTURES. The Service is also employing interns to examine its published documents for substantial references to landscapes. This effort has yielded 200 items out of 6,000 publications.

ISSUES

1. **The problems of preservation faced by various archives often begin in the field, when research and other records are created.** "Most field researchers lack a basic knowledge of the archival principles and techniques that contribute to record longevity."[11] Many preservationists fail to maintain records of their fieldwork, believing that a well-documented published paper will suffice. Yet, generally, the best sources of original data are the field records themselves. Even records that have been carefully stored may be lost because they have been created on media that have extremely short lifetimes. Paper, inks, magnetic tape, film are all subject to degradation. **In order to improve the ability of archives to store and retrieve records, it will be important for preservationists working in the field to be aware of the actions they can take to create and maintain long-term records.**

2. **A number of impediments exist to the application of computer technology to historic preservation information needs:**

- **lack of communication and coordination among database designers, leading to duplication of effort,**
- **lack of standardization in data systems and language,**
- **lack of Federal level leadership and commitment regarding the improvement of preservation data management,**
- **lack of computer networks for historic preservation, and**
- ***costs.***

Although computers have reduced the costs of storing and retrieving information, putting records on computers remains relatively expensive because it is generally labor-intensive. Volunteers and student interns can be helpful in entering data on computers. However, the help of volunteers upon which museums and other public institutions depend is not entirely risk free. Volunteers must acquire adequate training to be effective.

Training volunteers takes staff time from other important projects. It is important to interview individuals closely, train them carefully, and thus ensure that they perform their tasks properly.

For certain applications, an automatic optical scanner for transferring printed text to a computer database could lower certain labor costs, once the capital cost of the equipment is borne.

3. **Standardized formats are essential for convenient and reliable access to databases.** Yet, except in the world of research libraries, there has been little or no attempt to standardize or strictly define the various data elements or to create compatible formats and terms that would provide common access to documentation for individual

---

[11] Mary Anne Kenworthy, Eleanor M. King, Mary Elizbeth Ruwell, and Trudy Van Houten, *Preserving Field Records* (Philadelphia, PA: The University Museum, University of Pennsylvania, 1985). Although this report was developed specifically for archaeologists and anthropologists, it contains much information of use to all preservation disciplines and offers practical advice for preserving field records.

sites or structures.[12] Included in such databases should be nonprint records stored on optical disks or other high capacity media.[13]

4. **The preservation community needs a variety of information on preservation technologies and sources of expertise, delivered expeditiously.** One of the most important needs related to technology is for critically evaluated information on the conservation, restoration, and maintenance of historic structures. A centrally maintained technical database could provide such information. Among other things, such a database could strengthen communication among preservation professionals and their counterparts in natural science and engineering fields. However, before delivery of such information is possible, it will be necessary to develop a nationally accepted format within which existing and new information can be incorporated. One step in that direction would be to create a centralized database that provides listings of specialized databases.

Databases should be made useful and accessible to developers, planners, and others outside the professional preservation community. In the absence of a national preservation information network, interested parties are confined to conducting their research within individual States. They should have access to a database that lists the relevant databases in the United States and other countries. However, certain privileged data, such as the locations of archaeological sites, should be accessible only on a limited basis.

One of the difficult problems faced in such an effort is the establishment of comparable search and store parameters. It is important to resolve the way a database answers specific sets of questions, yet allow it to remain compatible with others. The NCSHPO, for example, is facing this problem in attempting to achieve compatibility between the SHPOs' databases, of varied quality and completeness, and the database designed for the National Register of Historic Places. The Computers Committee has, thus far, completed a list of fields for rehabilitation tax credit databases, fields for bibiographies, and an overview of database design.

The same institutional structure (such as a Preservation Technology Board) that would strengthen communication among historic preservation professionals and their colleagues in the sciences (see *Chapter 2: Introduction* and *Chapter 7: Technology and Preservation Policy*) could play a coordinating role in identifying improvements in the various computer databases for studies of historic structures and other cultural resources.

The Library of Congress, along with the National Archives and Records Administration, and some university manuscript collections specialists, are working toward establishing a Nationwide database. However, they face potential problems relating to the development of common standards. The National Archives houses retired Federal records. It is not clear that Federal Agencies themselves are striving to achieve commonality in studies being done for the purposes of computer-based data storage and retrieval.

Although the goal of coordinating the voluminous amount of existing preservation information and creating a national database for historic preservation might be attractive for reasons of simplicity of research, a national database looks neither technically feasible nor affordable in the short run. Because the field is multi-disciplined and fragmented, it is not bound by one accepted set of terms.

There is a need to provide data to a variety of preservation practitioners—scholars, Federal managers, architects, scientists, and craftsmen. Therefore efforts might be better expended on the technically easier task of establishing a network of links and keys to tie multiple databases together.

Technologies for Conserving Records

Although the focus of this study is technologies for sites, structures, and landscapes, conserving historic records is an important facet of the preservation process. Assuring the availability of historic records will require finding appropriate methods to convert deteriorating paper, film, and other media to less ephemeral media.

---

[12] For instance, by name, geographic or geo-political location, subject, date, or design history.

[13] The LOC Prints and Photographs Division, as part of LOC's Optical Disk Pilot Program, is storing thousands of images from several collections. See Joseph Price, "The Optical Disk Pilot Program at the Library of Congress," *Videodisc and Optical Disk*, 4 (1984): 424-432.

One potentially serious problem in the development and use of new data storage technologies, such as optical disks, is their long-term stability. First, the longevity of the recording media themselves is unknown.[14] Second, because the technologies are changing fairly rapidly, in the future it may be difficult to find the equipment to "read" certain records made in the last 50 years. For example, only a few institutions maintain the devices to play back cylinder recordings made in the early part of the century. Yet recordings such as those in the American Folklife Center's "cylinder project" provide Native American music that is rarely sung today.

In the 1930s, LOC sponsored a major survey of the Architecture of the South, funded by the Carnegie Foundation. As it was to be an archival collection, they used the best safety film of the day from Kodak. However, in the 50 years since they were originally made, the photographs have faded and cracked. Recently, LOC spent $60,000 copying 8,000 8x10 prints from the collection.

In addition to copying aging and threatened records, new technology can be used to make records previously inaccessible available. In order to make its collection of 25,000 glass plate negatives available to the public, LOC staff filmed them, reversed the polarity electronically, and recorded them on an optical disk. Now the Library is linking the optical disk to its automatic information retrieval system.

LOC staff have expressed concern over how long the optical disks and the disk players will last. Optical disk technology is still being improved and is, therefore, constantly changing. Most players now are built to National Television Standards. Yet, foreign standards are higher, and manufacturers are working on systems that will provide twice as many lines on a screen. Upgrading to higher standards later will entail greater expenditure.

Document Preservation and Copying

Architects and landscape architects frequently need to consult archival documents to understand the intent of a designer and to determine the integrity of a restoration. Yet, landscape architectural drawings are typically large (up to 25 feet long) and archivists have little experience with bulk conservation or copying of oversized documents. The sinks, drying racks, humidity chambers, and other specialized equipment for conserving large items are not readily available and must be custom designed and fabricated at great expense.

In general, architectural and landscape architectural plans were intended for short-term use and little or no thought was given to the possibility that they might later be placed in an archive. Many of the plans are, therefore, fragile. Many kinds of prints are often extremely faded and no known treatment exists to restore or stabilize them. The best that can be done is to copy them. However, because of the large format, poor image quality, or low contrast of the print, image enhancement may be required.

New document conservation technologies are needed.[15] Many letters contained in the Olmsted Association's correspondence file within the Library of Congress have faded so badly that they are nearly illegible without enhancement. Cost-effective methods should be found for copying, enhancing, and disseminating visual information. Preserving faded or outsized records is also labor-intensive and generally requires skilled personnel. It may be appropriate to set up regional centers specializing in the conservation of architectural drawings of structures and landscapes.[16]

---

[14] See *Preservation of Historical Records,* Committee on Preservation of Historical Records, National Materials Advisory Board, Commission on Engineering and Technical Systems, National Research Council (Washington, DC: National Academy Press, 1986). This study indicates that such materials as magnetic tape and disks are too perishable and unstable for archival purposes, with an estimated life span of no more than 20 years.

[15] For example, fumigation of records with ethylene oxide was standard practice until recently when it was discovered to be unsafe and the forbidden by Occupational Safety and Health Administration regulations. No satisfactory replacement has been found.

[16] See William H. Marquardt (ed.), "Regional Centers in Archaeology: Prospects and Problems," *Missouri Achaeological Society, Research Series 14,* 1977, for a discussion of regional centers applied to archaeology.

Maintaining Noncomputerized Information

Most of the current archival material is composed of drawings, photographs (negatives and prints), phonograph recordings, magnetic tapes, and texts. The problem of loss and misfiling of drawings and other necessary noncomputerized research documentation has become severe. For example, many Federal agencies cannot recall files for reference on construction or maintenance projects completed years before because they have become lost within vast records storage areas. There are often no finding aids associated with document storage systems.

Many Federal agencies, over the last several years, have discarded a variety of housekeeping documents relating to properties under their stewardship. Thus, a valuable source of information on past maintenance, repair, and restoration schedules and procedures has been lost for reference to today's conservators and historians. All such new information should be carefully documented and kept until such time as it can be computerized.

A formidable amount of available information and original documentation, such as tax records within State and local governmental offices and business and insurance records from company and corporate archives, still must be organized and retained because they are extremely useful to historians. It is important for preservationists to apprise business and corporate leaders of the potential historical value of such holdings. In addition, archival photographs are valuable as records of past landforms in an area. They should be preserved on stable film.

Some progress has occurred lately in correcting the problem of misfiled and mislaid records within storage systems by the LOC Committee for the Preservation of Architectural Records, which has a computer locator and tracking system. Massachusetts and Pennsylvania have made some headway in developing state-wide computer-based architectural record systems.

Other Federal agencies, such as the National Park Service, have been attempting recently to "unbury" approximately 6,000 technical reports by microfiling or microfiching those completed before 1965 (after they have been critically evaluated as correct and up to date). Those reports completed since 1965 have been sent to the National Technical Information Service and are now available to the public.

Information on Underwater Archaeological Resources and Technology

The types of information relevant to underwater archaeology and maritime preservation are extremely varied and widely scattered throughout such sources as libraries, Federal, State, and local agencies, and oil, gas, and mineral industry survey inventories. A national repository within which new research findings could be incorporated, and which provided locational aids for sources of maritime and submerged cultural resource information, would aid underwater archaeological research and preservation immeasurably.

Underwater archaeologists have made relatively little use of the information filed with the Minerals Management Service. The Service requires all oil, gas, or mineral exploration companies to conduct archaeological surveys of any three-mile lease blocks they want to lease. The companies must bear all survey costs of, for example, shallow, sub-bottom seismic survey, magnetometric survey, and side-scan sonar survey. They must allow archaeologists to review all of the data generated and recommend to the companies where to and not to drill. The companies have processed a tremendous amount of data from off-shore areas, but archaeologists have synthesized very little of it for the purposes of underwater archaeological research.

Chapter 6

Public Education

Contents

Page
Introduction 121
The Technologies 122
  Interpretive Labels, Signs, and Other Written and Graphic Information 122
  Interpreters 122
  Taped Walking or Driving Tours 123
  Electronic Media 123
  Interpretive Structures/Visitor's Centers 124
  Accessible Interpretation 124
  Designing Access to Sites 125
  Community and Public Education and Awareness 125
Issues 126

Public Education

INTRODUCTION

Public education is an extremely important component of the preservation process because most funding for historic preservation projects derives from the public, either through taxes, or through entrance fees at sites and museums. Public education and preservation research seek to answer the question: what can we learn from our material past? Information conveyed to the public is directly tied to what we learn from the study of archaeological sites and historic structures and landscapes. Preservation professionals have a responsibility to report their research findings to the public as well as to colleagues at professional meetings and in published articles.

Public education is most effective when, in addition to reporting research results clearly, it also helps the public understand the broad meaning of prehistoric and historic sites, structures, and landscapes. Fully realized public education explores the prehistoric and historic context for experience, actions, and events. It evokes an understanding of our relationship to those who preceded us as revealed in their cultural material.

Accessible, clearly presented information enables the public to understand, for example, that historic structures or designed landscapes are more than reflections of famous people or personal esthetic values, but are the products of a multitude of complex cultural forces that include economic, political, and social values as well. For example, information concerning prehistoric sites can assist in understanding the cultural and scientific achievements of Native Americans.[1]

Among Federal agencies, the National Park Service (NPS) has a long history of educating the public about cultural resources, which grew out of its interest in interpreting natural settings and values to its park visitors.[2] NPS sees cultural resource management and interpretation as complementary. "Interpretation communicates the significance and value of the resource to . . . 'the public'."[3] Interpretation also assists in "developing support for preserving" the parks' resources, including cultural resources.[4] As the director of NPS recently observed, "the preservation of the tangible evidence of this [our] past insures the preservation of the knowledge base. [It is] a base that can help us understand the fundamental relationships of men to each other and of men living in communities to their environment as a whole."[5] Research results are an important part of the significance and value of cultural resources, and often form a part of NPS interpretative presentations.

Hundreds of private, nonprofit organizations contribute greatly to the public's understanding and appreciation of preservation goals. Many of these organizations promote community and individual involvement in research or restoration. For example, the Crow Canyon Center for Southwestern Archeology in Cortez, Colorado, provides the opportunity for individuals, from elementary school age children to senior citizens, to spend time participating in an archaeological dig, experiencing the varieties of tasks and techniques of archaeology.[6] Other institutions, such as the White Mesa Institute, College of Eastern Utah in Blanding, Utah, may combine the experience of research with a regional educational tour.[7] The Alexandria Urban Archeology Program of the City of Alexandria, Virginia, has developed a highly structured program for involving the citizens of Alexandria in their city's past. The hours spent by the volunteers count toward fundraising by helping to secure matching research grants, and "the volunteer program also provides a vehicle for participants to conduct their own learning in a preferred area of education and work."[8]

---

[1] Thomas J. Schlereth, "Material Culture Research and Historic Explanation," *The Public Historian* 7, 1985, pp. 21-36. See also, Ray A. Williamson, *Living the Sky: The Cosmos of the American Indian* (Boston, MA: Houghton Mifflin, 1984), for an extensive discussion of prehistoric structures that display evidence of Native American interest in the motions of the celestial sphere.

[2] Barry Mackintosh, *Interpretation in the National Park Service: A Historical Perspective* (Washington, DC: U.S. Department of the Interior, National Park Service, 1986); see also Heather Huyck and Dwight T. Pitcaithley, "National Park Service: Historians in Interpretation, Management, and Cultural Resources Management," in *Public History: An Introduction*, Barbara J. Howe and Emery Kemp (eds.) (Malabar, FL: Krieger Publishing Co., 1986), pp. 371-387.

[3] *Cultural Resources Management* (Washington, DC: U.S. Department of the Interior, National Park Service, NPS-28), ch. 3, p. 34. See also *Interpretation and Visitor Services Guideline* (Washington, DC: U.S. Department of the Interior, National Park Service, NPS-6).

[4] "The Role and Responsibility of Interpretation in the National Park Service," position paper attached to a Memorandum from William Penn Mott, Jr., NPS Director, to NPS Regional Directors regarding Interpretation, Feb. 10, 1986.

[5] Ibid., p. 8.

Not only should public education focus on the results and interpretation of research, it should also include discussion of research techniques. Often the public is unaware of the part new technologies play in the analysis of prehistoric and historic sites, structures, and landscapes. Yet, many of the techniques are of interest in themselves. Demonstrating the analytical process could contribute to a deeper understanding and appreciation of the complexities of research. However, as is true of the research process, lack of availability of information has impeded adequate public understanding of this important facet of preservation.

---

[6] See Ricky Lightfoot, "The Duckfoot Site," *Archaeology*, March/April 1986, pp. 68-69 for a description of Crow Canyon's goals and some recent research results.

[7] Ray A. Williamson and Fred Blackburn, "The Living Earth and the Outdoor Museum," paper presented at the conference, Is the Earth a Living Organism? Amherst, MA, August 1985.

[8] Steven J. Shepard and John F. Stephens, "The Volunteer Program: Developing a Symbiotic Relationship Between the Profession and the Public," *Approaches To Preserving a City's Past* (Washington, DC: U.S. Department of the Interior, National Park Service Preservation Planning Series, April 1983), pp. 61-68.

THE TECHNOLOGIES

In addition to the traditional means of conveying information about prehistoric and historic preservation, including brochures, displays, museum exhibits, photographic slide presentations,[9] films and other media, techniques for interpreting research on cultural resources now include video, holographic images, and optical disks. Public television programs based on video footage taken during an excavation or renovation can be particularly effective in conveying a sense of the excitement of research. In addition, allowing the public access to components of a collection is useful for conveying the shape, size, and manufacturing details of the artifactual material.

Interpretive Labels, Signs, and Other Written and Graphic Information

These take a variety of forms, including brochures, maps and diagrams with points of interest highlighted, signs, or labels. These kinds of interpretative material are essential for curious visitors to derive the maximum benefit from visiting a historic site. Without such aids, visitors may be able to experience the ambience of the site, but remain uninformed about what they are seeing. Such information can be provided on two or three levels of complexity, depending on visitor interest and involvement.

One way to increase public awareness of significant landscapes is to provide interpretive signs along the highways, such as are used for historic routes, buildings, and monuments. The presence of a sign may entice a few to stop and invest the time to learn about the property. France, for example, has an effective program to call travelers' attention to historic sites, including landscapes, using explanatory signs along the side of the road. At some locations it is even possible to obtain information pamphlets.

Interpreters

Trained individuals who can explain the history and significance of a site, structure, or landscape are most effective at sites. Such interpreters can react immediately to visitors' questions. As noted above, NPS provides education to the public concerning cultural resources. NPS interpretative personnel provide tours, give slide shows, and a variety of informative talks concerning Park cultural and other resources. Effective use of technologies, such as tape recordings, movies, and slide shows, can enhance the ability of such interpretive staff to convey meaningful information to the public.

---

[9] Nancy E. Malan, "Producing Professional Quality Slide Shows," *Technical Report* 2, American Association for State and Local History, 1985.

Taped Walking or Driving Tours

Many museums, and some historic sites, offer taped tours of exhibits so that visitors may experience them at their own pace. Such equipment could be easily used for a variety of prehistoric and historic sites, structures, and landscapes. Some could be provided by the private sector. For example, a private nonprofit group allied with Fredericksburg-Spotsylvania National Battlefield Park provides tape cassettes on a rental basis for battlefield driving tours.

Electronic Media

Most sites contain far more information than can be conveyed to the public using traditional signs and written materials. Video tape, optical disks, and computers not only deliver information in new formats, they make it possible to treat a wide variety of information. Such devices can be used not only to impart information on the site, structure, or landscape at which they are located, they store and share a wide variety of contextual or comparative information.

For example, the staff of the Frederick Law Olmsted Historic Site in Brookline, Massachusetts, are developing a computer database that will soon be able to generate a list of properties designed by the Olmsted firm within or near a given area code. Visitors will be able to learn whether Olmsted properties are located near their homes. Eventually, the interpretive staff at the site hopes to be able to call up and display images of such properties on a video monitor. For comparative purposes, such an arrangement could display site plans, historic photographs, and modern views of the site. Clearly, this technology could also serve as an effective research tool.

Electronic media make possible greater public involvement with the educational materials because they allow direct interaction. Optical disks, especially, allow viewers to select different paths of information and to individualize their educational experience. For example, the American Folklife Center at the Library of Congress has developed a documentary optical disk describing life on a cattle ranch in Paradise Valley, Nevada.[10] On one disk, the producers have included full motion video with sound, a large, still picture archive (with captions) and oral histories in the form of filmed interviews that users can examine quickly and easily.

In underwater archaeology, as in other preservation areas, demonstrating the analytical process could greatly contribute to a deeper understanding and appreciation of the complexities and importance of underwater archaeology and maritime preservation. However, research results have not always been available in a timely manner, or in a form appropriate to public consumption.

Photo credit: National Park Service Submerged Cultural Resources Unit, Santa Fe, NM

Underwater video cameras provide a degree of information retrieval not easily duplicated by divers alone. These cameras have become essential tools of underwater archaeology because they enable immediate and detailed images for nondiving researchers.

---

[10] *The Ninety-Six: A Cattle Ranch in Northern Nevada*, American Folklife Center, Library of Congress, Washington, DC, 1985. See "Videodisc: The Ninety-Six Ranch," *Folklife Center News* 9, 1986, pp. 8-11.

Color video has become a very versatile tool in both high and low visibility underwater environments. It is relatively inexpensive and easy to use and capable of high resolution images. In addition, powerful new lighting systems can overcome the limitations on color balance and differentiation that occur 20 meters below the water's surface when ambient light is reduced. These techniques are among those which have been applied in the project to record and stabilize the *Monitor*.

The imaginative use of the various photo-imaging systems, such as stereo photography and video, can convey the essence of the underwater experience to those who do not possess the capabilities to dive themselves. The elderly and handicapped, for example, should be able to share some aspects of the underwater experience. In some cases it may be possible to view historic shipwrecks through submerged glass-lined compartments set into specially built tourist vessels.

Video cameras are particularly effective interpretive devices because they are relatively inexpensive and require only moderate training for acceptable results.[11] Interpretive staffs can use them to tailor presentations to meet specific local needs, and to document the park's holdings. They are also able to exhibit information about sites, structures, and landscapes that may be closed to visitors because they are too fragile or too difficult for the average visitor to reach.

Audiovisual techniques can enhance visitors' experiences enormously, but it should be noted that they must be planned for and tested carefully. At Kings Mountain National Military Park, South Carolina, a creative audiovisual approach misfired. Kings Mountain commemorates a battle between American loyalists and revolutionaries during the Revolutionary War. NPS featured this civil conflict by playing recorded arguments over speakers placed at either end of the main exhibit area of the visitors center.

Unfortunately, visitors entering the building too frequently found themselves under verbal fire: ". . . the exhibit did not work . . . The shouting match between the Loyalists and the Patriots confused visitors. . . ." Although the recordings began as the visitors entered the building, the accompanying visual exhibit was not necessarily synchronized with the sound. Insufficient testing clearly left the public with a far too real perception of Revolutionary confusion and strife.[12]

Interpretive Structures/Visitor's Centers

One of the most effective interpretive devices is a separate structure or pavilion that allows for the use of a variety of media—written, graphic, and video display. However, such structures may intrude on a historic site or landscape, so great care must be exercised in placing them to avoid visual conflicts and to ensure that their design is compatible with the setting. Existing structures can often be adapted to serve interpretive purposes.

Accessible Interpretation

Consideration of provisions for handicapped access to designed landscapes and structures is important for public education. However, for some historic public properties it may be difficult to provide access without impairing the historic integrity of the building or designed landscape.[13] A designed landscape whose only access is a long flight of steps, or a historic structure with extremely narrow staircases are possible examples. The Eugene O'Neill house in California has a brick sidewalk far too narrow for wheelchairs or walkers that is part of the house entrance vista.

In many cases, it may be possible to make part of the property accessible. In these cases, appro-

---

[11] Staff members of the NPS Submerged Underwater Cultural Resources Unit have made effective use of video cameras to document underwater resources in the National parks for management and protection. Park managers have also found that the footage so acquired can be used to display and interpret the resources to park visitors.

[12] Mackintosh, op. cit., p. 44.

[13] Charles Parrott, *Access to Historic Buildings for the Disabled: Suggestions for Planning and Implementation* (Washington, DC: Heritage Conservation and Recreation Service Technical Preservation Services Division, 1980).

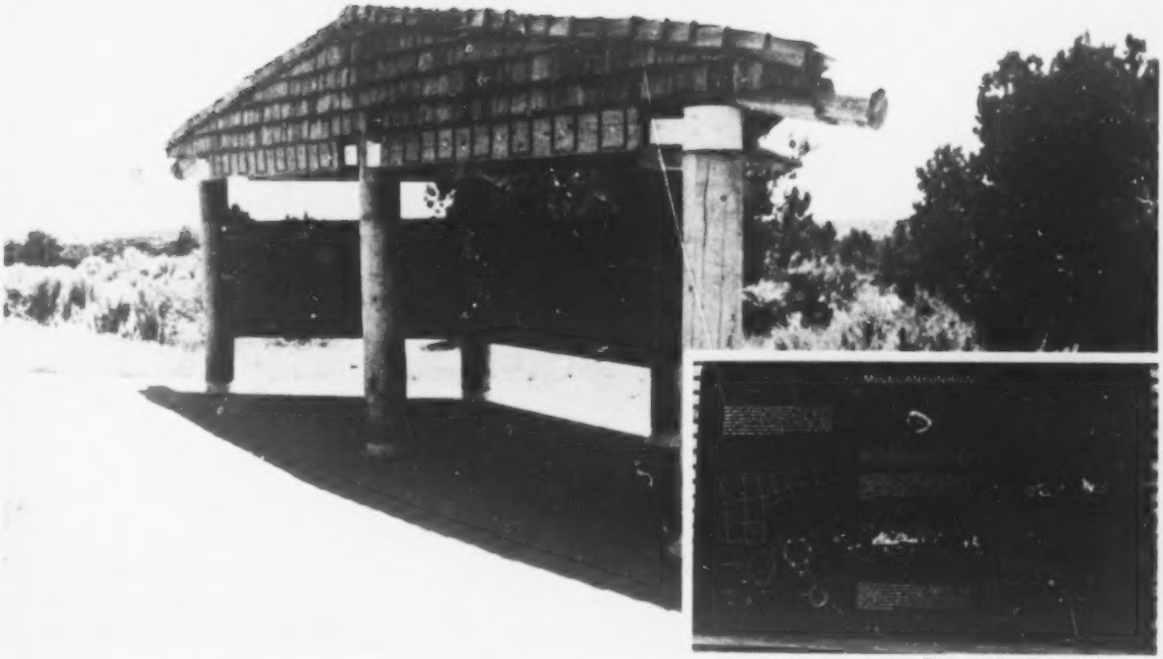


Photo credits: Ray A. Williamson

Interpretive structure and sign, Mule Canyon Ruin, southeast Utah. This structure is located to the side of the path leading to the stabilized and protected ruins of an ancient Pueblo Indian dwelling and sacred kiva.

priate educational tools and structures are especially important and should be designed and provided as an integral part of the site design or visitation process.

Video technology can be especially useful in assisting the handicapped to view a landscape or see the interior of a distant room because it is possible to set up video cameras in such a way that the handicapped can scan them from one or more fixed locations. In any case, all interpretive signs and labels should also be written in Braille. Recorded tours can be keyed to activate at points of interest and describe what can be experienced there.

Designing Access to Sites

For landscapes, one of the most important amenities the landscape architect can provide is a system of pathways and viewpoints to maximize the visitors' experience of important landscape features. Some zoo designers have been particularly effective in creating settings that channel visitor traffic and screen certain critical areas.

Community and Public Education and Awareness

Creating awareness of the value of historic properties within local communities is an important part of public education and preservation. In addition to providing information to the news media, managers of historic properties may find it beneficial to provide public lectures and other events for the local population either at the historic site or in the community.[14]

---

[14] For example, Sunnyside, in New York State, sends its interpretive staff into the local community to make citizens aware of their local history.

Obtaining the involvement and support of the local community, with participation in setting project goals, is one of the most important aspects of public education. Involving the local community gives its citizens a sense of contributing to the aims of the prehistoric or historic place, and imparts in them an interest in preserving the resource because they have contributed to it.

For example, the park staff at Cahokia Mounds State Historic Site in Illinois depends on close involvement of individuals from the nearby communities to assist in educating park visitors. Volunteers suggest projects that would make the park experience more enjoyable and participate with park rangers and interpretative personnel in carrying out these programs. They assist in archaeological excavations, the development of interpretive displays, and even publish a Park newsletter, *The Cahokian*.

Some historic sites involve the community by providing opportunities for local residents to participate in historic festivals,[15] or to volunteer as tour guides dressed in period costumes.[16] The issue of costuming interpreters, however, like that of presenting demonstrations or "living history" at cultural sites, is controversial within the profession. Such activities can, perhaps inadvertently, misrepresent the past by substituting charm, cleanliness, or nostalgia for historical reality.

General support can also be gained by forming "Friends of . . ." groups whose members can assist with maintenance, fund raising for special projects, and staffing sales and information desks, as well as serving as trained docents.

---

[15] English Heritage (The Historic Buildings and Monuments Commission for England) has made particularly effective use of local residents in historic festivals centered around historic landscapes, buildings, and monuments. See Malcolm G. Wood, "The Marketing and Interpretation of England's Heritage," paper presented at the Annual Meeting of the Society for American Archaeology, New Orleans, Apr. 23-27, 1986.

[16] Such volunteers work out best for the organization when they receive appropriate onsite training. The volunteers, in turn, gain the opportunity to learn more about the historic property and its historic relationship to the local community.

ISSUES

ISSUE 1:
Education is an effective means of increasing protection of cultural resources.

The excavation and collection of historic and prehistoric artifacts from both public and private land is a serious problem for cultural resource specialists. Fascinated by artifacts of earlier eras and other cultures, amateur collectors have made artifact collecting part of their recreational activity. Often, they are unaware of the damage their collecting inflicts on the available resource. Educational programs that describe the preservation research process and convey an understanding of the significance of prehistoric and historic cultural resources to the public could play an important part in reducing damage from such activities. Educational programs that actively involve the public and draw public input are likely to be most effective.

In addition to affecting public attitudes toward cultural resources on public lands, such programs may also educate private landowners to protect rather than dig up cultural resources on their own land. Prehistoric or historic cultural resources on private land are unprotected under current Federal preservation law. Such programs would also reduce the ease with which professional "pothunters" loot sites and could enable easier convictions under the Archeological Resources Protection Act (ARPA). Public outrage at the losses sustained by such activities is likely to increase if the public were more aware of the economic losses that can be incurred with looting and vandalism.

A variety of technologies exist for education, but they need to be used more effectively in order to affect significantly the retention of prehistoric and historic resources. Most interpretive displays or other educational materials lack information concerning the protection of sites and what the loss of those sites means in human or cultural terms. The Louisiana program, designed and excecuted by the Louisiana Division of Archaeology, serves as one important example of what can be done, at relatively little cost, to educate the public about protection issues (box C).

ISSUE 2:

Museums have an important role in contributing to the public's understanding of preservation goals.

Museums play a unique role in public education because they rely largely on the use of original natural objects or artifacts. They also employ photographs, drawings, or video for interpretation. Although museums have re-created whole historic rooms, or even dwellings inside their walls, in most cases it is impossible to recreate a rock art site or a landscape in a museum setting. Yet interpretation, both for research purposes and for public education, requires detailed knowledge of the local environmental context in which rock art and historic landscapes occur. Museum displays, however, tend to tell one story, instead of providing the multidimensional, multivalent explanation that designed and cultural landscapes call for. The appropriate use of optical disks or video might make possible a more dynamic, contextual approach that would include opportunities for the visitor to see a landscape or historic structure from different angles and at different seasons.

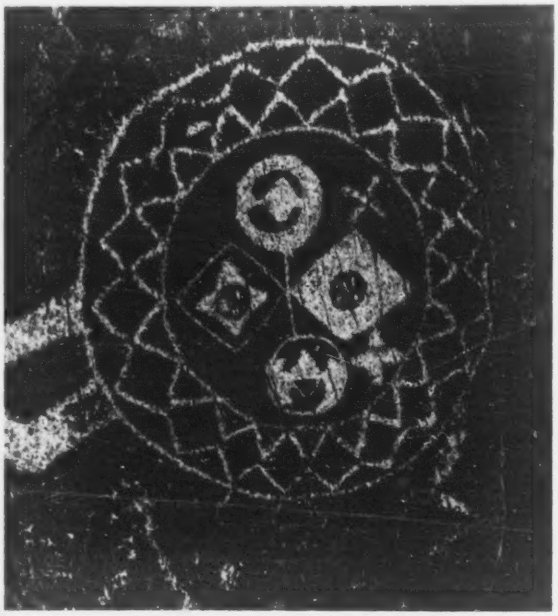


Photo credit: Ray A. Williamson

Ancient Pueblo Indian petroglyph of shield and warrior (on basalt) south of Santa Fe, NM. Native Americans pecked, carved, or painted many thousands of images on stone outcroppings throughout North America. Long known and admired for their beauty, they have only recently been studied and interpreted.

Museum curators tend to regard the museum as a facility for conserving prehistoric and historic artifacts and educating the public concerning their function and meaning. Most curators have not taken an active role in educating the public about the need to preserve cultural materials not in museums.[17] However, most of the same technologies that are used for interpreting museum collections to the public could be employed to alert it to the problems of protecting and preserving resources not yet in museums. Protection issues need to be included in interpretation.[18]

ISSUE 3:

Restoration and conservation techniques should be included in public education plans.

Although certain conflicts and uncertainties over the interpretation of prehistoric sites will continue, interpretive schemes would better serve the public if they explicitly incorporated information on the process of preserving sites. At York Minster[19] in England, preservationists planned to close the structure to carry out massive multi-year restoration, but were ultimately convinced to

---

[17] Curators of materials from a marine environment are familiar with the need to educate the public about protection issues because their artifacts are so fragile.

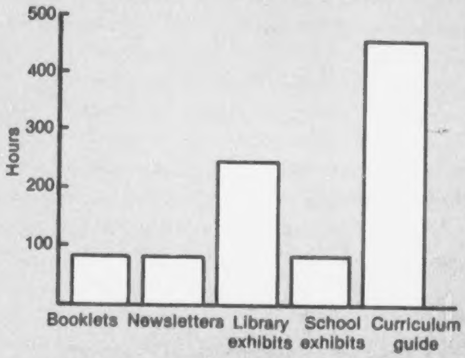
[18] For example, in 1984 the Denver Museum of Natural History mounted a small exhibit about Colorado Archaeology. A pamphlet distributed as part of the exhibit not only listed the major public archaeological sites in the State, but also included a warning about plundering archaeological sites and cited the State and Federal laws against collecting artifact on public lands. See "Colorado Archaeology: Riddles and Resources," Denver Museum of Natural History, 1984.

[19] See Bernard M. Feilden, *Conservation of Historic Buildings* (London: Butterworth Scientific, 1982), for more information on the restoration of York Minster.

Box C.—Louisiana's Public Education Strategies for Archaeology

About 85 percent of Louisiana's land is privately owned. Archaeological sites on private land have no formal protection under Louisiana law. Thus, in order to increase site protection in the State, the State's Division of Archaeology has embarked on a formal program to increase public understanding and awareness of archaeology. Louisiana's efforts demonstrate that not only can such a program reach a wide audience, it has a direct positive effect on the preservation of archaeological sites on private land.[1]

Time Required To Develop Various Projects

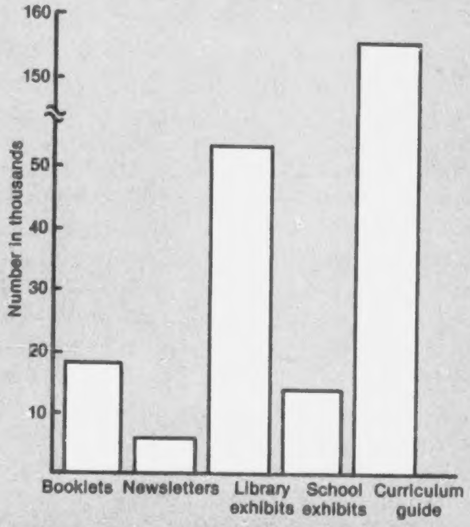


SOURCE: Louisiana Division of Archaeology.

The Louisiana program has attempted to communicate the following information inexpensively and in a manner that would not threaten landowners who may own significant archaeological sites:

- private landowners may have significant archaeological sites on their property,
- archaeological resources provide important and interesting information about past inhabitants of the land,
- scientific archaeological techniques provide the means to obtain the best information about archaeological sites, and
- not preserving resources results in the permanent loss of information.

Number of People Affected by Various Projects



SOURCE: Louisiana Division of Archaeology.

With only one person to coordinate and oversee its activities, the Division of Archaeology has developed the following set of educational materials:

- An illustrated booklet series—about 30 pages long, each booklet is written by an archaeologist who is an expert on the topic. Booklets are advertised in newspapers and archaeological newsletters and distributed free to anyone requesting them (average cost per copy, $0.50).
- Newsletters—these are 4 pages long and are distributed free to about 2,000 individuals, public libraries, and schools (average cost per copy, $0.08).
- Exhibits—for libraries and small museums. They include artifacts, display captions, maps, photographs, and original illustrations. They are shipped to borrowers in an aluminum suitcase (average cost of materials per exhibit, $600).

For classroom use the Division prepares smaller exhibits with artifacts that students can handle, maps, illustrations, and suggestions for classroom activities (average cost of materials per exhibit, $180).

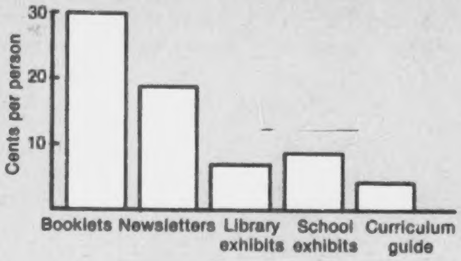
---

[1] The information in this box was derived from Nancy W. Hawkins, "Louisiana's Public Preservation Strategies," paper presented at the Annual Meeting of the Society for American Archaeology, New Orleans, LA, Apr. 25, 1986.

- Curriculum materials—169-page curriculum guide designed for use in junior high school classes (average cost per copy, $0.90).
- Workshops—the Division offers workshops for teachers around the State to introduce teachers to the materials and techniques they can use to teach about archaeology and site preservation.
- Slide shows—for the workshops and in conjunction with exhibits.

Finally, the division has "encouraged archaeologists receiving federal grant funds to include public participation in their projects."

Cost of Time and Materials of Various Projects Divided by the Number of People Affected



SOURCE: Louisiana Division of Archaeology.

Photo credit: Courtesy Dayton Museum of Natural History

A reconstructed prehistoric Indian house at the Incinerator Site in Dayton, Ohio. This thatched-roof dwelling represents archaeologists' interpretation of the original house forms at this location. It was built primarily with volunteer help from local citizens.

leave it open to the public who were able to view the work's progress in safety. The restoration generated a great deal of visitor interest and financial support, and provided a unique educational experience.

Likewise, in the United States, NPS has kept some historic buildings, among them the Clara Barton House in Glen Echo, Maryland, open for visitors during restoration and rehabilitation. Site managers can increase the public's concern over the continued "health" of historic structures by illuminating the process that preserves them.

Reconstructions of prehistoric or historic structures in a manner that preserves as much of the original methods as possible can be a source of particular enjoyment and instruction to site visitors. In one recent example, in which the reconstruction of a Paleoindian house in Virginia was carried out with volunteers using replicas of prehistoric tools, the house and the construction tools are now available for visitor inspection.[20]

A building, group of buildings, or a landscape can be historically significant for one or several reasons[21]—for a single event, day, or person, for outstanding design, craftsmanship, or artistic value, for representing a particular type, period, or method of construction, etc. Changes in use and occupancy may have wrought alterations that have assumed significance in their own right.

Buildings, for example, can demonstrate technological change over time, the history of building technology itself. It is often important for the history of changes in the use and function of historic structures to be incorporated into interpretive presentations. For example, the interpretation of a structure such as the Old Post Office in Washington, DC, owned by the General Services Administration, and recently rehabilitated to combined public and private office and commercial use, could include more information about its past function.[22]

---

[20] The Thunderbird Museum and Archaeological Park in Front Royal, VA. See "Indian Dwelling Rebuilt," *Archaeology* 39, 1986, p. 78.

[21] See *How To Apply the National Register Criteria for Evaluation*, U.S. Department of the Interior, National Park Service, Washington, DC.

[22] Page P. Miller, Nation Coordinating Committee for the Promotion of History, personal communication, 1986.

Chapter 7

Technology and Preservation Policy

Contents

Page
Introduction 133

Federal Policy 134
  The Federal Preservation Budget 134
  Applying Technology to Prehistoric and Historic Preservation 135
  Policy Options 135
  Federal Management of Prehistoric and Historic Cultural Resources 138
  Federal Policy for Looting, Vandalism, and Illicit Trade in Cultural Resources 140
  Federal Education Programs 142
  Underwater Archaeology 143
  Historic Structures 146
  Prehistoric and Historic Landscapes 146

State and Local Governments 148
  State Surveys 148
  State Records 149
  Technology Sharing 149
  Protection Laws 150
  Public Education 150

The Universities and the Private Sector 150
  Training 150
  Business and Industrial Contributions to Preservation 153
  Promoting Technology Transfer 153

Costs 154

Tables

Table No. *Page*
18. Federal Agencies With Major Roles in Underwater Archaeology and Maritime Preservation 144
19. U.S. Professional Societies With an Interest in Prehistoric and Historic Preservation 154

Figure

Figure No. *Page*
4. Annual Historic Preservation Fund Fiscal Appropriations 134

Chapter 7

Technology and Preservation Policy

INTRODUCTION

The Federal Government, "in cooperation with other nations and in partnership with States, local governments, Indian tribes, and private organizations and individuals," is responsible for providing leadership in preserving U.S. prehistoric and historic cultural resources.[1] The National Historic Preservation Act charges the Secretary of the Interior and the Advisory Council on Historic Preservation with administering and guiding the overall Federal preservation effort.

Participants in the OTA workshops asserted their belief that the Federal Government must continue to play the primary role in: 1) encouraging and supporting prehistoric and historic preservation; and 2) guiding the Federal agencies, as well as State and local governments, in conserving the Nation's cultural heritage. Through passing the several preservation laws (see app. A) as well as establishing and maintaining the Historic Preservation Fund (HPF), Congress has assumed the responsibility for formulating national historic preservation policy and providing the framework and means to carry it out. All Federal agencies are required by law to preserve prehistoric and historic properties on lands under their jurisdiction,[2] and each could become involved in developing relevant preservation technologies.

The National Historic Preservation Act, enacted in 1966 and amended in 1976 and 1980, gave the Federal Government the funding and authority to bring greater consistency and coordination to a multidisciplinary and multidirectional field. The mechanism enabled by this legislation ties together the national, State, and sub-State governmental levels and includes, among other components:

- The National Park Service's (NPS) Cultural Programs (see app. F) manage the National Register of Historic Places, administer the Historic Preservation Fund, provide technical assistance to Federal, State, and local agencies and the public on identifying, evaluating and protecting cultural resources; and develops historic preservation standards, guidelines, and regulations, which are promulgated by the Secretary of the Interior. NPS also manages most of the nationally significant prehistoric and historic sites in the United States.
- The Advisory Council on Historic Preservation "advise[s] the President and Congress on matters relating to historic preservation, recommend[s] measures to coordinate activities of Federal, state, and local agencies and private institutions relating to historic preservation."[3] It also "review[s] the policies and programs of Federal Agencies."[4] In particular, it is charged with encouraging public interest and participation in historic preservation, recommending studies, advising on legislation, encouraging training and education, recommending methods to improve Federal agency programs, and providing information on the Council's activities. The Council reviews and advises on projects undertaken or permitted by Federal agencies that may affect properties listed on or eligible for listing on the National Register of Historic Places (see app. F).
- The State Historic Preservation Offices (SHPOs) and Certified Local Governments (CLGs) receive yearly HPF matching grants to ensure that State, regional, and community preservation projects are carried out according to the nationally accepted standards developed within NPS cultural programs. Pursuant to the National Historic Preservation Act, the Governor of each State designates a State Historic Preservation Officer to administer preservation programs in

---

[1] National Historic Preservation Act, Section 2 (2).

[2] See especially, the National Historic Preservation Act, Sections 106 and 110.

[3] National Historic Preservation Act, Section 202 (a)(1).

[4] National Historic Preservation Act, Section 202 (a)(6).

that State. CLGs are approved by States and receive funding from them.

- The National Trust for Historic Preservation, chartered by Congress in 1949,[5] has, since passage of the 1966 legislation, received a portion of its funding through annual grants from the Department of the Interior and, thus, has also been incorporated into the U.S. preservation mechanism. The Trust fosters public participation in historic preservation, and provides preservation information. It also owns and manages certain historic properties (see app. H).

FEDERAL POLICY

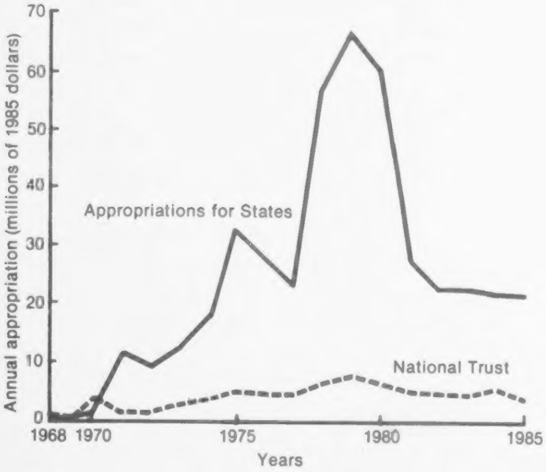
Previous chapters have identified a range of issues related to the use of technologies for prehistoric and historic preservation. This chapter relates these issues to Federal preservation policy and suggests options for implementing current policy. In certain critical preservation areas, this chapter also presents possible new policy directions.

The Federal Preservation Budget

The future use of technologies for historic preservation is threatened by declining funding. Pessimism over the declining Federal budget (figure 4) for preservation suffused OTA's five workshops. Workshop participants noted that the uncertainty over the amount and focus of Federal support for historic preservation programs bears directly on historic preservation technologies and could drive needed specialists away from the field. The eventual lack of expertise could jeopardize:

- Federal agencies' ability to identify, evaluate, and protect prehistoric and historic properties affected by their actions or under their control; and
- the quality of future restoration and rehabilitation, much of which is conducted outside the Federal preservation tax incentives program without the benefit or intervention of competent preservationists.

Figure 4.—Annual Historic Preservation Fund Fiscal Appropriations



SOURCE: National Conference of State Historic Preservation Officers.

Most OTA workshop participants viewed the continuance of vigorous Federal involvement in prehistoric and historic preservation crucial to the aims of preservation. They voiced fears over the future of SHPOs and CLGs if the Federal Government retreats further in support of their programs.

In their view, budget reductions weaken the Federal Government's traditional leadership in advancing preservation. SHPOs match 50 percent of the grants received from the HPF. They pass on 10 percent of that amount to CLGs. For each of the last 6 years, in the interest of returning more authority over preservation funding to the States, the Administration has cut funding from the HPF for the States. Each year, Congress has restored such funds; the annual appropriation for historic preservation has declined steadily in that time.

Nevertheless, interest in preservation has increased nationwide. This increase, which has been dramatic since 1980, began in 1976, when tax incentives for rehabilitation became available to owners of income-producing certified historic buildings.[6] Taxpayers reported rehabilitation expenditures of $635.5 million for 1982 and $1,201.2 million for 1983, for certified historic structures alone.[7]

---

[5] National Trust Act of 1949 (Public Law 81-408, 63 Stat. 937).

Increased preservation activity has necessitated increased technical assistance from the Federal Government, which administers the Tax Act Rehabilitation Certification Program through NPS and the Internal Revenue Service. The Federal Government has provided that help through NPS's Preservation Assistance Division. Ironically, the budget for their efforts has been reduced precisely during the time of greatest historic building rehabilitation activity. (See app. F for a brief description of NPS cultural resource activities.)

Both professional and nonprofessional preservationists have relied heavily on the Division's technical publications for protecting historic buildings. These publications, in the form of briefs, "tech notes," case studies, booklets, and reports, contain technical information concerning sound and carefully tested approaches to analyzing and resolving problems in historic structures.

Applying Technology to Prehistoric and Historic Preservation

Because of the Federal Government's traditional leadership role in prehistoric and historic preservation, and in developing advanced technologies for applications in many different other fields, effective use of technologies will require their continued involvement and support. The greatest single need is to improve the transfer and adaptation of technologies from other disciplines into preservation.

Technology transfer is the process of applying technology developed for one technical, geographical, or institutional area in another. Because most advanced technologies used in preservation were originally developed for use in different technical or scientific settings, considerable effort must often be exerted to apply them to the conditions prevalent in preservation. Research, training, information sharing, and development of standards are essential ingredients in this process. It is important for all Federal managers to be fully aware of the potential that cost-effective new technology holds for solving problems in the field, contributing to more effective care of cultural resources, and in analyzing and balancing the claims of competing interests.

Federal agencies provide a variety of means for encouraging and facilitating the use of new preservation technologies. One important mechanism is the government contracting mechanism, by which the Federal Government purchases services of preservation professionals. **When contracting with private firms or universities for preservation work, the agencies could encourage the use of certain technologies or approaches that have demonstrated a potential for cutting costs and maintaining preservation standards.** All relevant disciplines should be reflected in the Requests for Proposals (RFPs). For example, RFPs should always include specific mention of the historical and geological context of archaeological sites, or the historic context within which each historic structure or landscape is assessed, assigned value or significance, and treated.

Because the Federal Government coordinates its activities with the State Historic Preservation Offices, technological applications will eventually be transferred to the States and to local communities. However, lack of coordination among agencies, funding conflicts, and institutional apathy have slowed the adoption and widespread use of advanced techniques for preservation applications. The following paragraphs examine a variety of policy options by which the Federal Government can encourage and advance the applications of technology for prehistoric and historic preservation.

Policy Options

Establish a Federal Center for Preservation Technology

There is no central facility within which individuals or organizations can obtain assistance with technological problems relating to preservation. However, a central laboratory could bring together professionals from a number of disciplines to tackle preservation problems from all major areas—archaeology, historic structures, and historic landscapes. Such an institution would also function as a clearinghouse for sharing information among the various components of the preservation community.

---

[6] "Information on Historic Preservation Tax Incentives" GGD-84-47 (Washington, DC: General Accounting Office, Mar. 29, 1984).

[7] "Tax Policy and Administration: Historic Preservation Tax Incentives," GGD-86-112FS (Washington, DC: General Accounting Office, August 1986), table II.6.

The U.S. Government maintains a number of Federal or federally supported laboratories for research in climate, energy, weapons, and other areas of national concern. One or more university or Federal laboratory could be funded to provide sustained support for preservation research, as well as a variety of necessary services such as remote sensing, photogrammetric recording, or materials failure analysis.

Congress could direct the Secretary of the Interior to establish such a center within the Department of the Interior or some other Federal agency. The center would facilitate the transfer of technology from other areas into prehistoric and historic preservation by watching for and adopting new applications of existing technology, providing training for preservation professionals, and disseminating information on preservation technologies. In addition to meeting Federal Government requirements for preservation technologies, such a center would also serve State and local needs. It would:

Conduct Research on Preservation Problems.—It would either assume responsibility for the research programs related to historic preservation or coordinate with and supplement current programs. A center should have a small, highly trained staff and the facilities for testing and analyzing new methods, techniques, and equipment.

Such research could be carried out in a variety of agencies and institutions possessing specialized expertise in technical areas, but should be coordinated by a single agency focusing specifically on historic preservation. Several government agencies already provide some important technical services related to preservation needs:

- The National Bureau of Standards Center for Building Technology is the Nation's only integrated building research laboratory that studies and tests a variety of building materials, including adobe. It maintains contact with State agencies through such groups as the National Conference of States on Building Codes and Standards and numerous professional societies dedicated to building and construction technologies, such as the National Institute of Building Sciences.
- The National Science Foundation (NSF) Archaeometry Program provides limited funding for the development of new techniques in archaeological science.
- The National Aeronautics and Space Administration (NASA) Remote Sensing Applications Program provides some training and limited support for the developing archaeological and landscape applications of remote sensing from aircraft and spacecraft.
- The Department of Defense, through the Navy, funds the projects conducted by oceanographic institutes whose activities and technologies often bear on historic preservation. For example, the Navy and NSF (through its Marine Sciences Division) helped fund the Woods Hole Oceanographic Institution's Deep Submergence Program to document the *Titanic*.
- The National Oceanic and Atmospheric Administration, which, with technical advice from the National Trust for Historic Preservation and NPS, is documenting the *U.S.S. Monitor*.

Set Standards and Provide Training.—Although such programs are conducting high-quality research in prehistoric and historic preservation, they are not equipped to set standards or to provide the training that is essential to the efficient transfer of technology. As noted in chapter 2, there is a strong need for an institution that would identify research and development requirements, design preservation standards, disseminate information on new methods, and train professionals in the use of appropriate new technologies.

Because it is the largest single purchaser of preservation materials and services, the government would benefit directly from the increased expertise such training would provide. Training programs in historic techniques, similar to those offered by RESTORE, a New York-based nonprofit organization that provides training for tradespeople in the restoration and maintenance of historic buildings, should also be considered. In order for Federal managers to contribute to more effective management of historic properties, including landscapes as well as structures, it is essential that they become properly trained in the potential for new technologies to aid in the preservation process.

There is a strong need for workshops or seminars on techniques for historic preservation that include experts from many different disciplines. Many new methods, techniques, and kinds of equipment for historic preservation derive from natural science and engineering fields. Many cultural resource managers were trained in humanistic disciplines and may not be aware of the potential for new technology to solve historic preservation problems. A Federal center could aid this effort by providing direct funding for such seminars, and by encouraging professional organizations to provide the aegis for them.[8]

Collect and Disseminate Information About Technologies for Preservation.—Detailed summaries on the technologies available for archaeological sites, historic structures,[9] and historic landscapes, and their benefits and drawbacks, could help reduce costs for preservation and result in more effective research. To be most useful, these documents should also provide an inventory of sources of expertise within the field. In addition to developing a set of documents, a center should make such information available on-line, where it can be brought up to date periodically.

A national center would have the advantage of aggregating much of the specialized technological expertise now spread throughout the Department of the Interior and other Federal agencies. In addition to serving as the focal point for technology-related preservation information within the Federal Government, such an institution would provide needed assistance to State and local governments and to the private sector.

Establish a National Center for Preservation Technology

Alternatively, Congress could create a National Center for Preservation Technology, managed by a consortium of universities. Such an institution would be able to draw on a multitude of different skills in several universities, and in many university departments. Like the Federal center, it would serve as a focal point for the development and promulgation of preservation technology. It would, for example, also coordinate with the government agencies now responsible for research on different aspects of preservation technologies. However, because it would be free of many of the constraints imposed by being housed within the Department of the Interior, where other departmental funding and policy priorities can impede the development of new technologies, it might be more innovative than a Federal center. Though it would function primarily as a resource for the Federal Government, it would also serve State and local needs.

The National Astronomical Observatories, which are managed by the Association of Universities for Research in Astronomy (AURA) and funded by the NSF, might serve as an appropriate model for such an institution. Located in Tucson, Arizona, and in Cerro Tololo, Chile, they provide research facilities for the entire astronomical community, and also conduct their own research.

Because a national center based in the university community would support Federal preservation efforts, it would receive considerable Federal funding. However, it could also strengthen public/private ties for prehistoric and historic preservation. Such arrangements have always been an important feature of the preservation movement. Thus, a significant percentage of the funding could come from State and private sources.

Create a Preservation Technology Board

Additionally, Congress might wish to consider supporting a preservation technology board. Even if one of the two options for creating a center for preservation technology were adopted, a board composed of professionals from all parts of the preservation community would be needed to provide external guidance to a center and to determine current needs for preservation technology, develop standards for the application of new technologies, and aid in disseminating information. The professional societies with an interest in archaeology, historic structures, and historic landscapes should have considerable interest in such a board.

---

[8] The Army Corps of Engineers helped to sponsor a day-long workshop on Microcomputers in Archaeology at the 1986 Annual Meeting of the Society for American Archaeology. This workshop, which was extremely well attended, provided first-hand training for archaeologists in computer techniques for archaeology. Many of the programs exhibited there would be of utility for landscape preservation as well.

[9] NPS has published a very effective series of reports on technologies for historic structures (e.g., *Preservation Briefs, Tech Notes*).

Preservation efforts within the Federal agencies would benefit by a preservation technology board, which would serve to provide technical standards and information for the entire preservation community. Congress could foster the creation of such an organization by encouraging the Federal agencies with major responsibilities for prehistoric and historic preservation to provide its initial funding. A board could also foster the public/private partnership in preservation.

Federal Management of Prehistoric and Historic Cultural Resources

The Federal Government's prehistoric and historic preservation programs lack an effective central focus. Many participants in OTA's workshops expressed considerable concern over the lack of a central agency or framework for supporting technological applications for historic preservation. Given no effective central focus, it is difficult to set technical standards, provide coordination, and continuity among Federal agencies.

NPS could pursue this task by expanding its present core of experts and information on archaeology, historic structures, and historic landscapes. However, with the current institutional structure for preservation within the Department of the Interior, cultural programs do not get the attention they merit.

It would be possible to place cultural programs within a framework modeled on the European cultural ministry. The National Historic Preservation Act itself was produced after study of the European cultural ministerial experience, which in France goes back 150 years. While some European cultural resource management is significantly regionalized, as in West Germany and Italy, the central ministry nevertheless performs vital coordinative and support functions.

Since its establishment in 1916, NPS has been the foremost Federal agency for historic preservation, and despite the lack of strong Administration support for preservation (compared to other priorities), and limited budgets, carries out many excellent programs such as the Historic American Buildings Survey (HABS) and the Historic American Engineering Record (HAER).

Because NPS falls under the jurisdiction of the Assistant Secretary for Fish and Wildlife and Parks, some observers have voiced considerable skepticism as to whether it could ever bring cultural concerns to the forefront of the Department of the Interior's conservation agenda. The energies of Fish and Wildlife and Parks are directed largely toward natural environmental, energy, and other pressing land management issues. On the other hand, a director sympathetic to and deeply aware of the importance of the Federal role in historic preservation could exert the influence necessary to change the current balance. Futhermore, NPS itself is the owner and manager of the largest collection of historic properties in the United States and has special expertise in managing them.

The Advisory Council on Historic Preservation and The National Trust for Historic Preservation also provide technical advice to the Federal agencies and the public at large. A renewed Federal commitment to historic preservation, with more efficient and effective use of preservation technologies, will require these organizations to coordinate their efforts more closely. In addition, more involvement is needed with the National Building Museum in Washington, DC, chartered by Congress in the National Historic Preservation Act, Amendments of 1980 (see app. I). The Building Museum, because of its public/private nature, could play an especially informative and helpful part in advancing the understanding of building technologies and their role in preservation.

The preceding discussion raises issues that are outside the scope of this study. Yet they are serious enough to suggest further detailed study. Congress may wish to consider changes in the structure of the Federal Government's preservation efforts.[10] Participants in the OTA workshop and review process suggested several different options:

Establish a Separate Agency To Manage All Federal Cultural Programs

In addition to providing a central focus for all government programs in preservation, such an agency would be responsible for administering the National Endowment for the Humanities, the National Endowment for the Arts, and other culturally oriented programs.

Create an Independent Agency Devoted to the Care and Protection of Prehistoric and Historic Cultural Resources

Such a policy has the major advantage of providing coherence for the management of U.S. prehistoric and historic preservation programs. It would remove the primary responsibility for cultural resources management from the Department of the Interior, yet it would create a new institution that must be staffed and funded. An independent agency would be the logical place for a Federal center for preservation technology. However, it would lack the benefits of in-house expertise in the actual ownership and management of historic properties, including landscapes.

Reorganize the Department of the Interior To Provide for an Assistant Secretary for Natural and Cultural Resources

This option would bring all the cultural programs from NPS and other Interior agencies under the aegis of one office. It would be simpler to effect than creating an independent agency, and would increase the visibility and importance of preservation within the Department of the Interior. However, it would continue the current situation of maintaining the preservation function within the Department which, as noted earlier, has disadvantages as well as advantages for the national preservation programs.

Work Within the Current Preservation Structure

Even if the management structure for Federal preservation were left largely unaltered, there are a number of improvements to this Nation's preservation effort which are possible, given the direction provided by the National Historic Perservation Act, and other legislation. The initiation and execution of such programs will require direction and continued oversight by Congress.

The agencies could:

Inventory Their Preservation Needs and Plans for Implementing Them.—Each Federal agency has a different set of requirements for the preservation and protection of cultural resources. Each agency could be directed to make a periodic inventory of its overall cultural resources preservation needs, and report them to Congress. Such an inventory would help the agencies and Congress assess where additional attention should be applied to preservation. Cultural resources protection (see *Chapter 4: Restoration, Conservation, Maintenance, and Protection*), especially, could improve markedly if it had a higher priority within the Federal agencies, and if the agencies made stronger attempts to coordinate with one another as required by the Historic Preservation Act (Section 110).

Develop Sustained, Organized Maintenance Programs for Historic Federal Properties.—Except for catastrophic events, most deterioration from environmental processes can be slowed or mitigated by systematic, regular maintenance. Yet, most agencies have inadequate maintenance programs for their tangible cultural resources and tend to respond to preservation crises instead. **The Federal agencies could improve their programs for prehistoric and historic protection by instituting well-organized procedures of systematic and regular maintenance on the properties under their management and control.**

Improve Coordination and Information-Sharing Among Agencies With Respect to Historic Preservation.—The technologies for prehistoric and historic preservation are not generally integrated with larger government systems and programs. For example, the maintenance considerations appropriate to historic buildings are not integrated with modern building maintenance and conservation practices. Archaeological information is seldom part of an overall land management and environmental program. To date, concerns for soil erosion, forest management, game laws, and archaeological sites are isolated. Even where the data are accurate and included in geographical information systems, they are not exploited to monitor change or develop protection policies.

---

[10] The Advisory Council on Historic Preservation has just completed a study that treats issues related to the overall Federal preservation effort: *The National Historic Preservation Act: An Assessment* (Washington, DC: Advisory Council on Historic Preservation, September 1986). In addition, see *The Secretary of the Interior's Twentieth Anniversary Report on the National Historic Preservation Act* (The Section 504 Report).

Develop a Stronger Focus on the Application of New, Efficient Technologies for Preservation.—In coordination with a national preservation technology board, which Federal agencies could help initiate, the Federal agencies most concerned with historic preservation could focus more of their funding and other resources on the development of technologies for historic preservation. **Among such efforts should be the development of a central database for critically evaluated technical preservation information, and sustained funding for university laboratories that support the effort to develop new preservation technologies.**

Establish a Central Office To Collect and Disseminate Information About Preservation Technologies.—It would be most appropriate for NPS to assume the leadership in collecting and disseminating technical information because an important part of its mission is to provide information and training for preserving the Nation's cultural resources.* This information should eventually be placed "on-line," where it can be routinely updated. Other Federal agencies besides those within the Department of the Interior could aid in the collection and dissemination of information by contributing structural preservation and maintenance, as well as archaeological reports, completed under contract to State and Federal governments. As noted in *Chapter 5: Preservation Information*, NPS is now developing a database that will include most of these reports (the so-called "grey literature"). This database will be extremely important to future studies. However, not only should there be a listing of such grey literature, hard copies should be stored where qualified individuals can obtain them.**

In general, OTA workshop participants felt that **the Federal Government should take a leading role in developing databases and archives for preservation.** In doing so, it should include information from all relevant disciplines. For example, the historians are concerned about the lack of historical expertise among archaeologists. Because most sites, even prehistoric ones, have been affected by historical incidents, information concerning the history of an area is often extremely important in archaeology.[11] Such a database would enable the sharing of information among Federal agencies.

Federal Policy for Looting, Vandalism, and Illicit Trade in Cultural Resources

Looting and vandalism are extremely serious stresses to prehistoric and historic cultural resources. They are particularly damaging to prehistoric sites. In order to stem the theft of artifacts from public lands, **the United States needs a consistent national policy for dealing with illicit excavation and trafficking in stolen artifacts.** Because the needs and resources of each major region of the country are different, such a policy should provide for regional implementation.

To assist in stemming the illegal loss of irreplaceable artifacts from public lands, and the concomitant damage that looting causes, Congress may wish to amend the Archaeological Resources Protection Act of 1979 **and other statutes to permit private registration of antiquities obtained in the course of archaeological excavations on private land, conducted by trained archaeologists** (see app. C for one such proposal). Such antiquities should be registered with a State or local agency. Registration information should include sufficient information about each artifact to allow the owner to understand its archaeological origins and connection to the prehistoric peoples from which it derives. Registration would allow archaeologists and others to locate artifacts for research purposes. The availability of microcomputer systems makes the maintenance of a registry in each State much less costly and much easier than it might have been only a few years ago.

---

*NPS has discussed the desirability of issuing a technical brief in which the various technologies are described and sources of information and expertise supplied. However, it has not yet produced such a report.

**Because they may contain sensitive information, not all such reports should be broadly available. Potential users should be screened by the SHPOs.

[11] See, for example, *The River of Sorrows: The History of the Lower Dolores River Valley* (Denver, CO: Department of the Interior Bureau of Reclamation and National Park Service, no date) for a historical study of an area about to be inundated. The area was the site of an intensive archaeological survey and salvage study.

Registration of scientifically excavated artifacts is likely to enhance the value of registered artifacts relative to unregistered ones. Such increase in value might provide economic incentives for private landowners to have their sites properly excavated and recorded, rather than dug solely for their marketable artifacts. Registration might also assist in educating landowners to the scientific value of using the best possible excavation methods. However, sale of artifacts from excavations would have the disadvantage of dispersing some collections, which would reduce the ability to restudy them.

The Convention on Cultural Property Implementation Act[12] (see box D) prohibits importation of stolen cultural property that is documented as belonging to the inventory of a public monument, museum, or similar institution in a State party to the UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property.[13] It also restricts importation of archaeological or ethnological materials from other countries on request and subsequent agreement by the United States. However, it is just being implemented and further experience will be needed to test its efficacy in stemming the international flow of cultural property.

U.S. law does not protect against export of irreplaceable items of this country's history from the United States to other countries. The UNESCO Convention encourages each State party to register cultural property[14] for the purposes of controlling import into other countries. As experience is gained in implementing the Convention on Cultural Property Implementation Act, **to explore**

Box D.—Convention on Cultural Property Implementation Act (Public Law 97-446)

This act implements the 1970 UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property, which has now been signed by 58 countries, including the United States.[1] Two enforcement mechanisms are available:

I. **At the Request of a State party, Imposes U.S. Import Restrictions to Protect Endangered Archaeological and Ethnological Materials (Article 9)**: it establishes a mechanism whereby the President may enter a bilateral or multilateral agreement or take unilateral emergency action to protect, through the imposition of U.S. import restrictions, archaeological or ethnological materials that are part of a country's cultural patrimony and are in danger from pillage. Each request for import restrictions from a State Party is reviewed by the Cultural Property Advisory Committee which makes recommendations to the President, or his designee, as to whether restrictions should be imposed.

   A list of materials that are denied entry into the United States under this provision is published by the U.S. Commissioner of Customs. No such lists have been published to date. However, in October 1985, the Government of Canada asked the United States to impose import restrictions to protect endangered Canadian archaeological and ethnological material. The Canadian request is under consideration.[2]

II. **Prohibits Entry of Stolen Cultural Property (Article 7(b))**: Any article of stolen cultural property documented as belonging to the inventory of a public monument, museum, or similar institution located in a State Party is prohibited importation into the United States after April 12, 1983 (or the date the State Party implemented the Convention, whichever date is later). The U.S. Customs Service is responsible for enforcement.[3]

---

[1] See Maria Papangeorge Kouroupas and Ann J. Guthrie, "The Cultural Property Act: What It Means for Museums," *Museum News*, June 1985.

[2] See "Canada Submits Request for Cultural Property Protection," *USIA World*, December 1985, p. 12.

[3] Quoted from "Information on U.S. Assistance Under the Convention on Cultural Property Implementation Act," "Synopsis," Washington, DC: United States Information Agency, January 1986.

---

[12] Public Law 97-446.

[13] Fifty-eight countries have signed the UNESCO Convention.

[14] See Articles 6 and 10 of the Convention.

ways in which the registration of artifacts suggested above could be expanded to other prehistoric and historic cultural property.

Improvement of the protection of endangered sites, structures, and landscapes will require more personnel trained in cultural resources law enforcement. It is also important to make law-enforcement work schedules more flexible to allow for patrols during the evenings, weekends, and holidays. In addition, because looters and vandals have access to advanced technology, including sophisticated radios and detection systems, law-enforcement personnel should be well-equipped to detect and apprehend them. In some cases, especially in the West and Southwest, some agencies do not always serve as effective role models in their treatment of cultural resources. If agency personnel are perceived as not caring about protecting cultural resources, local residents can hardly be expected to understand the need for treating them with respect.

Federal Education Programs

Federal managers are often hard pressed to carry out their responsibilities in geographical areas where citizens may not fully appreciate both the cultural and economic importance of preserving prehistoric and historic resources. Strengthening Federal, State, and local educational and interpretive programs appears to be a cost-effective way to improve the protection of archaeological sites, historic structures, and landscapes. Archaeology and historic structures and landscapes have a natural appeal for the public. Preservationists outside the Federal Government could aid Federal agencies in their tasks by informing Members of Congress, and officials of Federal agencies, State, and local governments, of the importance of historic preservation in their communities.

The following options suggest several ways in which citizen awareness of the value and importance of preservation could be improved.

Popularizing Preservation/Protection Issues on Federal, State, and Local Levels, Including Industry

This can be accomplished, at least in part, by:

- Publicly recognizing the positive actions that various organizations, including private ones, have taken to raise the consciousness of the public. The Historic Preservation Act (Section 110 (h)) provides for an annual preservation awards program. Increasing the visibility of this awards program would help popularize protection concerns.
- Educating Congress, the Administration, Governors, and the State Attorneys General about the extent and importance of preservation/protection problem.

Like the general public, many public officials are unaware of how many cultural resources the United States has lost, as well as their importance to research. As a result such officials may not give sufficient attention to the problems caused by looting and vandalism. The "Take Pride in America" campaign, initiated by the Secretary of the Interior, should help focus the attention of public officials and other citizens on the importance of maintaining our prehistoric and historic cultural resources.

Strengthening the Implementation of the Archaeological Resources Protection Act (ARPA)

ARPA has been only marginally effective in stemming the losses of archaeological resources. Yet, unless prosecutions are pursued vigorously the positive effects of applying law enforcement technology will be lost. One way to strengthen ARPA's effectiveness is to improve the educational programs for law enforcement officers by giving thorough training in ARPA's provisions and regulations.[15]

---

[15] "Final Uniform Regulations, Archaeological Resources Protection Act of 1979," *Federal Register* 49, No. 4, Jan. 6, 1984.

In addition to training agency law enforcement personnel, the Federal Government should institute more courses such as those given by the Federal Law Enforcement Training Service Institute in Atlanta, Georgia, to train Federal and State judges and prosecutors about the nature of cultural resources and the laws protecting them.[16] Improved cooperation among Federal agencies in training programs would enhance the ability of officers in each agency to carry out their duties with respect to the protection of cultural resources. Such interagency training should include training on methods to combat the use of technology by looters, who have begun to employ sophisticated methods to find archaeological resources and to avoid detection by law enforcement officials.

Some regions have organized interagency training workshops,[17] but they tend to be ad hoc, and highly dependent on the particular mix of personnel available in a region. Such training should be held on a regular basis and should be as independent as possible of the interests of particular individuals.

Support Avocational Interests

A variety of privately funded programs now exist to support the interests of individuals in archaeology and historic preservation. The agencies could make better use of such programs to support Federal programs by helping such groups pursue their interests. Often, rather than supporting those with avocational interests in preservation activities, agency personnel perceive them as increasing their workloads vis-a-vis supervision and granting permits. Yet, these and other interested groups can be extremely effective in helping to focus local public opinion toward protection of prehistoric and historic sites.

Underwater Archaeology

The United States lacks an effective national policy regarding the protection of prehistoric and historic submerged and maritime resources. Even with the passage of the Submerged Lands Act of 1953, by which the Federal Government granted the States title to the lands and natural resources within 3 miles of their coastlines, historic shipwrecks and other submerged cultural resources within those limits of U.S. territorial waters are vulnerable to the work of salvors, few of whom are attentive to the appropriate preservation of historic shipwrecks. Many are well-financed and equipped with the latest marine technologies for locating and recovering materials from the deep.

All Federal agencies are required by law to preserve prehistoric and historic properties on lands and under waters within their jurisdictions, but several have major roles in managing underwater cultural resources (table 18).[18] They can provide a variety of means for encouraging and facilitating the uses of new technologies in underwater archaeology and maritime preservation. This area of preservation has been an extremely neglected element of the Nation's cultural resource base.

Current national preservation policy is weak and fragmented with respect to maritime and submerged cultural resources, particularly historic shipwrecks. The various existing cultural resource laws, supporting regulations, standards, and guidelines attendant to the Federal, State, and local governmental preservation efforts are not being applied with equal fervor to submerged cultural resources. In part this is the result of the fact that no single Federal department or agency has been

---

[16] The recent law enforcement efforts in Southeast Utah in which hundreds of Anasazi pots, allegedly dug up from public lands, were seized in Federal raids is a good example of what can be done if law enforcement efforts are well-coordinated and carried out with the cooperation of local, State, and Federal agencies. Jim Robbins "The Great Artifact Grab," *Chicago Tribune Magazine*, Aug. 10, 1986.

[17] For example, the NPS Southwest Regional Office held a protection workshop in May 1986 that included Federal officials from NPS, the Forest Service, the Bureau of Indian Affairs, and the Bureau of Land Management.

[18] National Historic Preservation Act, Amendments of 1980, Section 110.

Table 18.—Federal Agencies With Major Roles in Underwater Archaeology and Maritime Preservation

Advisory Council on Historic Preservation
Bureau of Land Management (DOI)
Bureau of Reclamation (DOI)
Environmental Protection Agency
Fish and Wildlife Service (DOI)
National Forest Service (DOI)
National Oceanic and Atmospheric Administration (DOC)
National Park Service (DOI)
U.S. Army Corps of Engineers (DOD)
U.S. Geological Survey (DOI)
U.S. Navy (DOD)

charged with coordinating and directing a strong, visible national program for maritime preservation.

The first criteria for evaluating and nominating shipwrecks to National Register were finally written in November of 1985 nearly 20 years after enactment of the Historic Preservation Act of 1966. Even though Federal agencies are required under the several historic preservation laws to consider the treatment of cultural resources in their overall planning, few acknowledge or exhibit sufficient awareness of submerged cultural resources.[19]

The following statistics demonstrate the longstanding lack of attention to underwater and other maritime cultural resources, even within historic preservation:[20]

- Of the more than 45,000 buildings, objects, and sites listed in the National Register of Historic Places, only 120 are ships.
- The Historic American Buildings Survey (HABS) has recorded thousands of buildings and other structures as well as documents and photographs in 53 years. However, the Historic American Merchant Marine Survey (HAMMS) was dissolved only 18 months after its inception during the New Deal in 1937. Thus, the opportunity to record perhaps thousands of ships and other vessels was lost.
- In 1979 the Department of the Interior issued standards and guidelines for the rehabilitation of historic buildings.[21] These standards have stimulated more than 9,000 privately funded rehabilitation projects carried out with tax incentives. No such standards exist for ship restoration.
- The rehabilitation of historic buildings using tax incentives has reached billions of dollars since 1976. No such incentives exist to attract private dollars to ships.
- Nearly every State has surveyed some portions of historic resources and nominated thousands of properties to the National Register. However, few States have begun to survey their submerged cultural resources.
- Confusion over National Register of Historic Places qualifying criteria for listing may have excluded many ships from that roster. Register guidelines State that siting is critical in assessing the integrity of historic structures. However, ships and other vessels move or are buried. Present Register criteria are too "building specific."

Recent legislative initiatives may signal greater attention to underwater archaeology and maritime preservation. The Senate Committee Report to the Fiscal 1985 Act Providing Appropriations for the Department of Interior and Related Agencies[22] stipulated that NPS, with the National Trust for Historic Preservation and the maritime constituency:

> . . . review the maritime resources of the Service and recommend the appropriate future role for the Service and for the private sector in preserving those resources; conduct a thematic review of maritime resources and recommend a set of priorities for the preservation of those resources and the appropriate Federal role in addressing those priorities.[23]

In addition, the Senate Report (99-397) to the 1987 appropriations bill for the Department of the Interior and Related Agencies adds $100,000 to the appropriation for the National Trust for

---

[19] Exceptions are the National Park Service, which maintains a Submerged Cultural Resource Unit in Santa Fe, NM, and the National Oceanic and Atmospheric Administration, which is in charge of the Federal effort to preserve the Monitor.

[20] Editor's Column, "Listing Ships," *Preservation News*, June 1986.

[21] "Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines," 48FR 4416-44742, Sept. 29, 1983.

[22] Senate Report 98-578, Aug. 6, 1984, to accompany H.R. 5973.

[23] Ibid.

Historic Preservation, specifically targeted for maritime preservation.

Federal agencies have been extremely slow to adopt appropriate advanced technologies for the purposes of conducting underwater archaeological research. Underwater archaeology shares with other preservation areas the lack of a strong, defined, visible central focus for technology within the Federal Government.

The Abandoned Shipwrecks Act (H.R. 3558/S. 2569)

Legislation pending in Congress, The Abandoned Shipwrecks Act of 1985 (H.R. 3558 and S. 2569) seeks to resolve conflicting claims and court decisions by clarifying State title to historic abandoned shipwrecks. Historic shipwrecks in coastal waters contain a wealth of important information concerning the exploration and settlement of this country. Yet efforts to protect them for research and public interpretation are hampered by current Admiralty Laws, under which historic shipwrecks are treated as abandoned property, whose contents may be recovered by salvors with no legal protection for the historic information they may hold. Admirality law was inherited from English Common Law and was intended to apply at the time of wrecking to save life and property. Without clear Federal legislation establishing public interest in, and government ownership of historic shipwrecks, these resources will continue to be highly vulnerable. Other nations, such as Cyprus, Australia, Norway, and the Seychelles, have enacted national laws regulating the management of all cultural resources within the waters of their outer continental shelves.[24]

Passage and implementation of the proposed Abandoned Shipwrecks Act could make it possible to preserve significant historic shipwrecks for future generations by ceding jurisdiction, ownership, and oversight of them to the States.

The House Bill as currently written:

- asserts U.S. title and transfers to the State's title to abandoned shipwrecks that are substantially buried or embedded in submerged lands of a State when included in or determined eligible for inclusion in the National Register of Historic Places,
- declares the the law of salvage does not apply to these abandoned shipwrecks,
- specifies that the act will not affect any suit filed before the date of enactment,
- reaffirms Federal ownership of abandoned shipwrecks on Federal lands,
- retains any existing Federal admiralty and salvage law for all shipwrecks not covered by this bill, and
- directs the Advisory Council on Historic Preservation to develop guidelines to assist the States and the Federal Government in carrying out their responsibilities and to allow for noninjurious recreational exploration and private sector salvage of shipwreck sites.

The Senate Bill includes these provisions and additionally:

- finds that cooperative efforts (by finders/salvors, State and Federal agencies, amateur and professional archaeologists, sport divers, and other members of the public and private sectors) must be promoted to locate and protect abandoned historic shipwrecks on, in, or under State submerged lands;
- states that any person engaging in the recovery of a shipwreck which a State asserts title to shall receive reasonable compensation for such recovery.

In order to improve the preservation of underwater cultural resources, it will be necessary to raise the visibility of underwater archaeology within the Federal Government. Not only NPS is involved, but the rest of the Federal establishment as well. There is no underwater archaeologist stationed in Washington, with direct access to the upper levels within the Department of the Interior. Nor is there a designated archaeologist to coordinate with other Federal agencies such as the U.S. Navy and the National Oceanic and Atmospheric Administration. Yet the Federal Government, as it does in other areas of preservation, could provide the leadership in underwater archaeology. It possesses most of the technologies, experts, and funding, but the efforts of its agencies are extremely fragmented and, therefore, uneconomical.

---

[24] P.J. O'Keefe, *Current Developments Regarding Regulation of Marine Archaeology Outside Territorial Waters*, University of Sydney; cited by Douglas Shallcross and Anne Giesecke, "The Status of Federal and State Regulation of Underwater Cultural Resources: Lessons of the Treasure Salvors and Cobb Coin Cases, *Underwater Archaeology: The Proceedings of the 14th Conference on Underwater Archaeology*, 1986.

For example, such programs as NPS's Submerged Cultural Resources Unit, headquartered in Santa Fe, New Mexico, could be given much greater support. It has expanded from a team charged with investigating the effects of reservoir waters on archaeological materials in the Southwestern United States, to a group required to study, record, and propose management of shipwrecks throughout the country. It has been instrumental in successfully establishing underwater parks under the management of NPS to which various levels of public access for educational purposes is permitted.

The Sanctuary Programs Division of the National Oceanic and Atmospheric Administration, with the cooperation and involvement of the National Trust, manages the U.S.S. Monitor Project, and has incorporated underwater cultural resources concerns in planning for all existing sanctuaries. It has also established a process for designating leisure marine sanctuaries for cultural resources.

Historic Structures

Institutional impediments have slowed the Federal Government's efforts to maintain its own stock of historic structures. The Federal Government is the largest single owner of property and buildings in the country and the largest purchaser of architectural and engineering services. It is, therefore, in a position to exert more influence on historic preservation than any other entity and can provide a variety of means to encourage and allow the use of new technologies for better preservation of historic structures. However, a lack of coordination among its agencies, insufficient funding, and institutional apathy have slowed acceptance and greater use of appropriate new technologies that might ease its preservation burden.

Within the Federal agencies that administer large or numerous tracts of Federal land, serious conflicts may arise over the agency's mission and fulfillment of historic preservation responsibilities. The U.S. Army, for example, has 10,000 buildings built before 1940 under its control or, about 2 percent of its total stock. However, because the Army is oriented toward new construction and because it believes that the preservation of historic structures is often labor-intensive and, therefore, expensive, it devotes minimal attention to protecting those historic buildings under its stewardship.[25]

Likewise, the U.S. Postal Service favors new construction to house its increasingly mechanized mail handling operations. The agency argues that its older facilities, some of the most architecturally distinguished and historically significant governmental and civic structures in the country, are inadequate for the volume of mail that must be processed and are uneconomical to maintain. Yet such a view does not take into account the importance of these buildings to the heritage of the United States.

Prehistoric and Historic Landscapes

Although the National Historic Preservation Act contains no impediment to the identification and preservation of landscapes, neither does it specifically mention them.[26] **However, not expressly naming historic landscapes as worthy of being preserved allows the agencies to overlook landscape concerns in their preservation programs.** It may be appropriate to amend the National Historic Preservation Act to include explicit reference to landscapes.

One of the major impediments to preserving historic landscapes is the poor state of knowledge of the Nation's prehistoric and historic landscapes. Until recently, little effort has been expended to identify and document significant landscapes, and no comprehensive, centralized listing of significant American landscapes exists.

---

[25] At the request of the House Subcommittee on Public Lands, of the Committee on Interior and Insular Affairs, the General Accounting Office is currently conducting a study on Federal management and maintenance of historic buildings.

[26] For example, see Section 101 (a)(1)(A): "The Secretary of the Interior is authorized to expand and maintain a National Register of Historic Places composed of districts, sites, buildings, structures and objects significant in American history, architecture, archaeology, engineering, and culture."

Even the National Register of Historic Places can provide only a crude list of National Register properties that are related to landscape architecture. Many significant landscapes are either not on the National Register or are classified under other themes, such as structures or districts.

A comprehensive national historic landscape survey would draw together the information we now have on significant landscapes and identify landscapes missed in previous, haphazard efforts. A survey of designated historic landscapes has already been initiated by the Historic Preservation Committee of the American Society of Landscape Architects (ASLA). The National Park Service has endorsed the survey and disseminated the survey form (see app. F) to State Historic Preservation Officers (SHPOs). However, the ALSA survey depends on volunteer support, which, though essential to success of the survey, could lead to inconsistent results. To assist in meeting prehistoric and historic landscape preservation goals, NPS has identified 12 projects for standards and models (app. F). In order for the survey to be consistent and carried out in a timely manner, it will be essential to apply such standards and models uniformly on a nationwide basis at all levels of public and private preservation efforts. The resultant information should be made available through a central clearinghouse on a uniform database.

It is crucial to increase public awareness of historic landscapes if they are to be preserved. Passage of the Olmsted Heritage Landscapes Act of 1985 (Olmsted Act)[27] would materially aid the collection of information on all U.S. historic designed landscapes.[28] By focusing attention on the many landscape projects designed by Frederick Law Olmsted and his firms,[29] the Oldmsted Act would likely increase interest in other, non-Olmsted designed historic landscapes. The bill also calls for NPS to conduct a theme study of all historic landscapes identifying potential national landmarks.

Several States, including Ohio, Massachusetts, and New Mexico, have made strides in the identification of landscapes. Although their efforts are related to specific, discrete projects, there is hope that such landscape surveys will be institutionalized.

Certain places, landscapes, and outdoor sites are sacred to Native American groups. It is important to include the views of Native Americans when reaching decisions about historic landscapes considered sacred to these peoples.[30]

The Federal Government could aid in the identification and preservation of significant prehistoric and historic landscapes by clarifying landscape terminology in the National Register, improving interagency information flow, and focusing more attention on landscape preservation.

There are several institutional impediments to the preservation of prehistoric and historic landscapes. One of the primary barriers to identifying and preserving significant landscapes is the lack of consistent terminology. The Historic Preservation Committee of the ASLA has proposed terminology that could be used. Such efforts should be examined carefully and consistent terminology developed and promulgated. It may be appropriate to include landscape terminology in the National Register, to assist the procedure of nominating significant prehistoric and historic landscapes.

In order to improve the preservation of historic landscapes, NPS should focus more consistent attention on landscape preservation in its management of cultural resources, and coordinate landscape policies and programs with other agencies. For example, although NPS has a chief historian, a chief archaeologist, and a chief architectual historian, it has no chief landscape architect. Increased attention to landscapes should include emphasis on the role of technologies in preserving them.

---

[27] H.R. 37—see House of Representatives Committee on Interior and Insular Affairs Report 99-148, 99th Cong., 1st sess.

[28] Section 4 of the proposed act directs the Secretary of the Interior ("through the utilization of existing procedures and programs") to "encourage the identification, preservation, and commemoration of historic designed landscapes."

[29] Over three generations, the Olmsted firm, whose Brookline, MA, office is now a National Historic Site, managed by NPS, designed such parks as Central Park in New York City; Franklin Park in Brookline, MA; and Prospect Park in Brooklyn, NY.

[30] See, for example, the American Indian Religious Freedom Act of 1978 (Public Law 95-341).

In addition, although NPS is now considering how to preserve its own historic landscapes, it could intensify those efforts.[31] NPS could also make a greater effort to include consideration of landscapes in its various publications.[32] It could also exercise leadership and enhance its own landscape preservation effort by upgrading and highlighting the function of gardening and grounds maintenance as a crucial resource management role in the service.

Finally, there are no uniform standards for landscape preservation. NPS publications, *National Register of Historic Places Bulletin* 18, "How To Evaluate and Nominate Designed Historic Landscapes," and the NPS Handbook, "Cultural Landscapes: Rural Historic Districts in the National Park System," will assist the effort to develop standards for nomination to the National Register of Historic Places. However, technical standards equivalent to those that have been generated for the built environment are also important and need to be developed for landscapes.

STATE AND LOCAL GOVERNMENTS

As demonstrated from the beginning of the preservation movement, State and local governments, along with private organizations and many individuals, have provided the will and the incentive for preserving significant aspects of this Nation's history. "Because of the diversity of the Nation in which we live, American history is local history."[33] Local residents wish to have a strong hand in preserving their own history. As noted earlier, under the terms of the National Historic Preservation Act, through the State Historic Preservation Offices, States are responsible for a wide variety of preservation activities. Although the technical guidance and support of the Federal Government can assist States' efforts to make more effective use of technologies for preservation, ultimately the impetus must come from within the States.

This section discusses several areas in which the Federal Government may provide specific and direct technical assistance to State and local governments. It also suggests how States may improve their effectiveness in applying technologies to the management and preservation of State and local prehistoric and historic cultural resources.

State Surveys

Identifying significant prehistoric and historic cultural resources is the first step in preserving them for the education and enjoyment of future generations. State offices should be encouraged to maintain surveys on computer databases so they can be enlarged and corrected frequently and cost effectively (see *Chapter 5: Preservation Information*, for discussion of State databases). A yearly report to the State legislature detailing that year's efforts might assist in obtaining additional support for statewide work.

Archaeological Resources

In spite of many citizens' long history of interest in collecting Native American artifacts (e.g., projectile points, pipes, carved figures, and pottery), local knowledge of prehistoric sites is often not recorded at the State level. Even many historic archaeological sites are not recorded on State surveys. Recording such resources at the State level would enhance their preservation for research and public interpretation.

Underwater Archaeological Resources

As noted elsewhere in this report, there is a strong need for States to inventory their underwater cultural resources. Even inland States may possess significant underwater resources in lakes, streams, and rivers.[34]

---

[31] See for example, John Donahue, "Historic Landscaping," *National Park Service CRM Bulletin*, 9, No. 2, 1986, pp. 1,8, which mentions briefly both landscape design considerations and technologies for reproducing historic trees.

[32] For example, the *Preservation Briefs* and *Tech Notes* published by the NPS Preservation Assistance Division.

[33] Marilyn Nickels, National Park Service, personal communication, 1986.

Structures

In large part because of the influence of the Historic American Buildings Survey (HABS) and the National Register of Historic Places, many State and local historic buildings and monuments have been identified. As a result of such survey, and strong local efforts, many significant structures have been preserved and the economic benefits returned to the States as well as the local communities.[35] However, much more needs to be done. Surveys of structures, as well as archaeological sites and landscapes will be assisted by greater efforts in public education (see below and *Chapter 6: Public Education*).

Landscapes

Only a few States have made a concerted effort to survey their prehistoric and historic landscapes; in general, the States' approaches to landscape issues are very uneven. Many States have active programs in rural landscape preservation,[36] yet few of the SHPOs have experts in historic landscapes. **The Federal Government could provide support for regional environmental and cultural resource preservation centers that would focus much of their effort on landscapes.** As suggested earlier in this chapter, such regional centers, perhaps managed by a consortium of regional universities, could significantly enhance the States' ability to identify and preserve historic cultural and designed landscapes.

State Records

Because of their importance to the State context, State administrative records, maps, photographs, surveys, studies, and other archival materials require proper handling and treatment. State professional archivists and historians need training and other support to learn to apply the latest technological developments for archival procedures, including temperature and humidity control systems and conservation techniques. The Federal Government could aid this effort at small marginal cost by making such Federal training available for qualified State personnel.

Technology Sharing

The 1980 Amendments to the National Historic Preservation Act stipulated greater coordination and streamlining of operations in the SHPOs. Many States have attempted to use computer technology to improve their preservation efforts and to achieve better interdisciplinary interaction. For the States, improved planning has been tied to receipt of HPF monies. In this time of dwindling Administration support for State and local preservation activities (see figure 4), the States and localities might benefit from more aggressively studying the potential of new technologies that can help them meet their preservation goals. However, the States will need continued Federal funding for preservation in order to be able to apply cost-effective and useful technologies. Until they have such funding, they will continue to depend on the Federal Government for technical assistance.

Technology sharing can be arranged through various kinds of agreements (cooperative agreement, memo of understanding) between Federal agencies and State or local entities. The Florida State Conservation Laboratory at Tallahassee, for example, under a cooperative agreement with NPS, is treating two pieces of artillery and a set of metal doors for Gulf Islands National Seashore.

State agencies, such as State highway departments, frequently use sophisticated technologies and equipment that would be applicable to preservation needs. State universities and local preservation institutions might profit from sharing that equipment. A major problem for State educational systems is the cost of equipment, yet one of the needs repeatedly emphasized by OTA workshop participants was a corps of preservation professionals trained in the uses of technologies. State funding for the agencies with equipment could be coupled with encouragement for sharing the equipment.

---

[34] Michigan underwater resources are owned by the State, but managed by the Federal Government.

[35] See Thomas D. Bever, "The Economic Benefits of Historic Preservation," Heritage Conservation and Recreation Service, U.S. Department of the Interior, May 1978. See also, National Trust for Historic Preservation, *Built to Last* (Washington, DC: Massachusetts Department of Community Affairs and the Preservation Press, 1977).

[36] As previously mentioned, Ohio, Massachusetts, and New Mexico all have active landscape programs.

Protection Laws

In States where State laws are weak on protection of prehistoric and historic sites, structures and landscapes, strengthening such laws would assist in preservation. In some States, however, strong laws are weakly enforced. In those cases, State legislatures may wish to encourage increased enforcement to prevent loss or damage to the State's heritage.[37]

Even in situations where federally managed resources have been stolen or damaged, the assistance and involvement of the State and local communities and law enforcement personnel are essential in carrying out successful prosecution.[38] Thus, it is important for State and local preservationists to educate their citizens about the economic and quality of life benefits of preserving their cultural heritage.

One park manager in New York City[39] recommends putting people in the park as much as possible—using sites, structures, and landscapes for many kinds of community activities. The effect is twofold: it protects park resources, such as buildings, from graffiti and other forms of vandalism, by having people and activities there; and it invests the resources with community value, which may increase the protection of park resources when they are not in use.

Public Education

An important component of all phases of preservation, public education (see *Chapter 6: Public Education*) on the State level could be encouraged by State agencies and the universities. Traveling exhibits organized by the State museums or archives may encourage local preservation activities. Aid programs, like Ohio's "Old House Doctor Clinics" encourage citizen involvement and sophistication about preservation issues.

Local constituencies can be brought into the political process in support of cultural resources only if they know that those resources exist. Yet their support is important in helping to shape local policies to recognize and protect prehistoric and historic community assets. Information may be presented through the media or through a combination of lecturers who appear before local civic and special interest groups and onsite lectures, tours, and other public events.

---

[37] Even in some communities that have experienced considerable loss of prehistoric artifacts from public lands, a majority of those who have engaged in taking them would prefer that they remain in the local community. See Paul Nickens, et al., "A Survey of Vandalism to Archaeological Resources," op. cit. ch. 5.

[38] Brent Ward, U.S. Attorney, personal communication, August 1986.

[39] Tupper Thomas and Paul C. Berizzi, "Prospect Park: Rebuilding the Past for the Future," *Parks and Recreation*, June 1985, pp. 24-29.

THE UNIVERSITIES AND THE PRIVATE SECTOR

Preservationists within the universities and private firms play a major role in delineating and furthering the understanding of technologies for the preservation of prehistoric and historic structures, landscapes, and archaeological sites. The relevant professional societies have and should continue to take their part in developing new technologies and disseminating information about them, by emphasizing training workshops at professional meetings. All three groups would also further the quality of the preservation effort by communicating historic preservation needs to manufacturers whose products could be adapted for application in the field.

Training

Because historic preservation is highly interdisciplinary, the quality of training becomes extremely important. A common assumption is that all preservation professionals receive the same kind of graduate training, speak the same language, or work in the same manner as, for example, civil engineers whose higher education is more uniform. However, graduates who have entered historic preservation from a variety of university majors or programs often engage in inconsistent field practices. Graduate programs in historic preservation have generally demonstrated disappointingly little support for the assimilation of a substantive technical and scientific component. This appears to be so not only in architecture, but in archaeology and landscape architecture as well.

In the United States, archaeology is generally considered a subdiscipline of anthropology. Because of this, there has been little demand for graduate school training in advanced technologies. In the United States, the majority of graduate archaeologists do not acquire physical scientific or mathematical degrees in undergraduate colleges and universities. In Europe, however, university archaeology programs place more stress on the use of scientific techniques developed in the natural sciences and engineering.

Most underwater archaeology is possible only because of the new and advanced technologies developed for the Navy and the oil, gas, and mineral development industries. Therefore its practitioners must be well-versed in such technologies. The very few university programs dedicated to the discipline, such as those at Texas A & M University, East Carolina University, and Arizona State University recognize this dependence and train students in their use.

Current curricula in architecture, architectural history, or American studies have not been developed explicitly to address the rapid technological changes affecting the building and construction fields and, thus, may be inadequately preparing students to cope with the complexities of preserving a growing structural resource base. Few architectural schools incorporate structural materials conservation courses within their programs. The lack of emphasis on the basic sciences in historic preservation programs and the lack of attention in architecture school programs to the causes and effects of structural materials failures, are resulting in inappropriate uses of both contemporary and historic building materials, such as reinforced concrete, wood, and structural steel. Many architects are often unfamiliar with the behavior of materials under the various stresses to which they can be subjected. For example, reinforced concrete, metals, or wood exposed to extremely moist environments present difficult preservation problems. Many, if not most, preservation program faculty elsewhere have little access to laboratory facilities and are thus unable to introduce the needed technical component into their educational process.

At least two university graduate programs are combining architecture and structural conservation with natural science and technology.

The Center for Preservation Research at the Columbia University School of Architecture

Members of Columbia's departments of mineralogy and chemistry helped found the building materials conservation laboratory, demonstrating that university scientists can be persuaded to permit the use of their own facilities and help establish laboratories for preservation purposes. The center allows students to devote 25 out of 60 program credits to science and provides a conservation laboratory for the study of building materials.

The Georgia Institute of Technology's Center for Architectural Conservation

The Center is a research, information, and design facility concerned with all aspects of technology for building conservation. Specialists at the center work in conjunction with research offices and laboratories located throughout the school's campus, including the Georgia Tech Research Corporation, and derive support from Federal and State governments, private industry, and the Institute itself. Center staff have recently begun work on several innovative projects that exploit computer technology.

Building Evaluation.—The Building Inventory Inspection Program (BIIP), undertaken in cooperation with NPS in 1982, generates and updates by means of a microcomputer structural assessment reports based on 150 elements of site, architectural, and engineering systems. Each report also provides data on public health, handicapped access, fire, and life safety. Center staff are also applying the BIIP approach to assessing the condition of National Historic Landmarks.

Information Systems.—The Cultural Resource Assistance Information Network (CRAIN) is an online database that will collect and deliver information on conservation professionals, testing facilities, organizations, products, etc. The network is designed to transmit technical notes and documents and will be augmented by center staff to perform specialized research beyond its scope.

Database Design.—The Census of Treated Historic Masonry Buildings, designed and programmed for NPS, is part of an international effort to identify, monitor, and evaluate protective treatments for masonry buildings. Observations of conditions will be recorded and stored every 2 to 5 years to form an easily accessed microcomputer database.

Training.—Interactive optical-disk systems will combine live-action, still photographs, text, graphics, and sound for training programs in architectural conservation.

Although the history of landscape architecture is generally taught in landscape architecture programs, few schools have emphasized in their curricula the preservation and restoration of historic landscapes, and the research, planning, and design involved. Such topics may be included as part of a design course, however, rather than as part of a course on historic landscape design. No school of landscape architecture awards a degree in the history of landscape architecture, although graduates of advanced degree programs may have been able to emphasize historic preservation in their work or theses.

Universities could usefully become involved by expanding their educational programs to include courses in historic preservation for landscape architects, historians, landscape contractors, and horticulturalists. They could also assist in developing additional educational materials for gardeners and maintenance personnel. University programs are excellent places to explore the use of advanced technology for training and educational purposes.

In spite of shortages in both human and financial resources, preservationists would benefit from working more closely with scientists in the university setting to achieve a more well-rounded and balanced approach to technical training. They could, in addition, create a "market awareness" concerning historic preservation. If faculties of history, American studies, or architecture could be convinced that there is genuine interest in historic preservation, they would integrate it as a major subject within their departments. Some programs, like the American Studies Program at George Washington University, have begun such integration. Also the American Studies curriculum at Notre Dame focuses on tangible cultural resources.[40] But technological approaches are generally not stressed in those programs.

Currently, any graduate student wishing to pursue a more technically and scientifically oriented focus in historic preservation must be highly motivated in "putting together pieces" or tailoring specially designed programs with the approval of a supportive faculty. The professional societies supportive of the goals of prehistoric and historic preservation could do more to foster research and support those historic preservation programs in need of technical and scientific strengthening.

For example, the efforts of the National Association of Corrosion Engineers have led to the establishment of university laboratories, whose research can assist in preserving metal structures. The Masonry Research Institute Foundation has provided seed money for the study of historic masonry buildings. The National Institute of Conservation has funded both Columbia University and the University of Florida to enhance materials conservation curricula. Also, the Association for Preservation Technology, through its *Bulletin*, newsletter, books, and monographs, and the publishers of the *Old House Journal* and *Technology and Conservation* have for some time been sharing technology by disseminating information.

The National Trust for Historic Preservation, as a partially private organization and a conservator of historic properties, could advance and sponsor technical education and research. Students interested in the sciences will avoid masters degree programs in historic preservation if starting salaries in the field remain as low as they have been. The National Trust and professional societies could assist in locating funding to attract students with undergraduate degrees in such important subjects as structural engineering, metallurgy, and microbiology to the field of historic preservation. The number of students with scientific educational backgrounds entering such preservation programs has been small.

---

[40] Thomas J. Schlereth, "Historians and Material Culture," *OAH Newsletter* 13, 1985, pp. 3-5.

Training of Craftspeople

There are are not enough skilled restoration craft specialists to meet the increasing demand for their services.[41] Neither are there enough architects, structural engineers, and contractors knowledgeable of restoration craft techniques or their proper execution and application. Training programs such as RESTORE in New York are designed to give craftsmen, the "men and women on the scaffold" the opportunity to upgrade restoration skills and acquire new ones. They also acquaint architects, structural engineers, and contractors with preservation issues and state-of-the-art maintenance and restoration of historic building materials.

RESTORE attempts to return to craftsmen the decisionmaking capability that has been gradually and systematically denied them by the construction and building industries over the last few decades. Craftsmanship has been sacrificed to uniformity, mass-production, and economy. Restoration is challenging, varied, and often difficult. Every practitioner involved in structural restoration and rehabilitation should comprehend the behavior of materials and their basic physical and chemical properties. As preservation activities continue to increase in the United States, more training programs such as RESTORE will be needed.

Business and Industrial Contributions to Preservation

The industrial and business communities' contributions to many preservation projects have been strong. The effort to provide private funding for the restoration of the Statue of Liberty is an outstanding example of such contributions. The project captured the public's attention; enhanced enthusiasm for historic preservation nationwide; and, perhaps most importantly, generated an enormous amount of private sector financial, material, and technical support. It also demonstrated the necessity for understanding and applying the latest technology in historic preservation. The restoration represents a timely opportunity for the preservation community to forge closer ties with industry and business.

Many businesses, especially those involved in land development or extraction of natural resources, contribute to preservation by paying for cultural resources surveys, or for excavation or mitigation of damage to archaeological resources. For example, in developing its carbon dioxide wells and pipeline in the Four Corners area of the Southwest, the Shell-Cortez Pipeline Corp. recently paid $600,000 for archaeological work, which was 3 percent of its total investment in the area. Its work resulted in significant information concerning early Navajo occupation in the San Juan Basin, and of early Spanish occupation of the Rio Grande Valley.[42]

Promoting Technology Transfer

As noted in several chapters, the transfer of technology from the natural sciences and engineering to preservation is one of the most important considerations in creating new methods, techniques, and equipment for the preservation field. Federal agencies, State, and local governments, the universities and industry and the business community all have a part to play in the transfer.

Public/private partnerships in specific projects can be extremely fruitful in promoting technology transfer. For example, underwater archaeologists might pursue agencies such as the U.S. Navy more assiduously to ascertain the possibilities of joining routine mapping projects or training and practice missions in diving. The Navy is often very appreciative of archaeological expertise. The Navy's Submarine Development Group runs unmanned deepwater submersibles with excellent side-scan sonar capability to depths of nearly 20,000 feet. The group's charter obligates it to support and aid civilian scientists, such as geologists from the institutions of oceanography. Underwater archaeologists could identify and take advantage of such opportunities.

---

[41] Even West Germany, which has a long history of training for craft specialists, is experiencing a shortage of artisans and other craftsmen capable of carrying out preservation tasks. Günter Schelling, Bavarian Administration for Palaces, Gardens, and Lakes, personal communication, 1985.

[42] Ruthann Knudson, Woodward Clyde Associates, personal communication, 1986.

Within the private sector, a number of formal and informal opportunities for encouraging interchange of ideas leading to the transfer of specific techniques, methods, and equipment are available. Box E provides an example of such interchange for underwater archaeology and maritime preservation.

Professional organizations (table 19) provide excellent forums for sharing research, including research methods and techniques through annual meetings, publications, and special seminars and workshops. To promote technology transfer, it is important that such meetings provide for natural scientists and engineers to interact with members of the preservation community.

The Society for Archaeological Sciences has the unusual distinction of being founded in 1977 specifically to encourage interdisciplinary studies among archaeologists and their colleagues in the natural sciences. Its membership includes chemists, physicists, geographers, geologists, paleobiologists, paleobotanists, and archaeologists. Chance interactions of archaeologists and natural scientists can be highly effective in isolated cases. However, more effective technology transfer requires coordination in institutionalizing and improving the contribution of archaeological sciences to the preservation of cultural resources.

Table 19.—U.S. Professional Societies With an Interest in Prehistoric or Historic Preservation

American Anthropoloigcal Association
American Association for State and Local History
American Folklore Society
American Institute of Architects
American Institute for Conservation of Historic and Artistic Works
American Society for Conservation Archaeology
American Society of Landscape Architects
Archaeological Institute of America
Association for Field Archaeology
Association for Preservation Technology
Conference on Underwater Archaeology
Council on America's Military Past (CAMP)
Historic Landscape Alliance[a]
National Association for State Archaeologists
National Conference of State Historic Preservation Officers
National Institute for the Conservation of Cultural Property, Inc.
National Trust for Historic Preservation[a]
Society for American Archaeology[b]
Society for Archaeological Sciences
Society for Historical Archaeology
Society of Architectural Historians
Society of Professional Archeologists

[a] Not a professional society, but has many professionals as members.

[b] See David J. Meltzer, Don D. Fowler, and Jeremy A. Sabloff (eds.), *American Archaeology Past and Future* (Washington, DC: Smithsonian Institution Press, 1986).

SOURCE: Office of Technology Assessment.

Finally, professional publications, especially those that encourage interdisciplinary articles can facilitate information exchange, as can reviews of books on preservation knowledge and techniques.

COSTS

Many traditional activities associated with prehistoric and historic preservation are extremely labor-intensive, but in some cases, new techniques will reduce labor costs. Many new technologies require the use of expensive new equipment and the services of highly trained personnel. For example, the new and innovative technologies for locating and analyzing submerged sites, developed primarily for application by the U.S. Navy and the oil, gas, and mineral exploration industries, are versatile, sophisticated, and also particularly costly (see box F). It has, therefore, not always been possible for preservationists to achieve overall cost reductions. Yet, these and other advanced technologies, such as neutron-gamma ray inspection, and remote sensing from space have provided useful information not otherwise obtainable.

Box E.—Private Sector Contributions to Underwater Archaeology and Maritime Preservation

- *The industrial component of the private sector*, mainly the oil, gas, and mineral exploration companies testing and drilling offshore have, for years, used specially engineered instruments, tailored to their requirements to locate deposits under the seabed and to repair underwater rigging platforms. These industries have demanded state-of-the-art remote sensing and remotely operated deepwater submersible craft technologies, many of which eventually find their way into archaeology.
- *The commercial segment of the private sector* is represented by about 25 commercial salvors who operate primarily off the coasts of Florida and Texas.[1] Their work represents the greatest threat to the integrity and long-term preservation of underwater archaeological sites.
- *The research segment of the private sector* is represented by the various oceanographic institutions (see table) whose work and projects often touch on underwater archaeological concerns. Many receive significant funding from the Federal Government, chiefly, the Navy.

---

[1] *Fact Sheet*, the Society for Historical Archaeology, Advisory Council on Underwater Archaeology, Washington, DC.

Major Oceanographic Institutions

Duke University
Johns Hopkins University
Lamont Doherty Geological Observatory
Oregon State University
Scripps Institution of Oceanography
Texas A&M University
University of Alaska
University of Georgia
University of Hawaii
University of Rhode Island
University of Southern California
University of Washington
Woods Hole Oceanographic Institution

Box F.—Costs for Underwater Archaeology

In underwater archaeology, costs will remain high, probably for some time, although certain locational technologies for underwater archeology, such as LORAN, have dropped considerably. A LORAN system only a few years ago cost about $10,000. It is now easily available for about $600. While some possibilities for technological cost reductions exist, the current price of doing business in the field is formidable. Only the magnetometer, which costs about $15,000, is within the range of the average underwater archaeological budget. The sub-bottom profiler and side-scan sonar each cost about $35,000—or about $8,000 per month to lease. Even when some technologies are combined for maximum value and efficiency, their costs are prohibitive, almost 95 percent of the typical underwater archaeological project budget. Boats at least 30 feet long are necessary for deploying remote sensing instruments. They are expensive to charter, dock, fuel, and insure. Electronic positioning systems are far more accurate and efficient than hand-held compasses. A reliable system such as the Motorola Mini-Ranger costs about $25,000 to purchase and approximately $5,000 per month to rent. These figures represent common, reasonable monthly expenses for a properly equipped boat, about $33,000 per month not including costs of boat, crew, instrument maintenance, living expenses, and contingencies.

A total cost of about $25,000 to $50,000 per month, depending on whether or not equipment is leased or purchased, represents a believable figure for initiating field work. When that is multiplied by 2 or 3 months, the length of many project seasons, costs become the primary concern. Even the least expensive of the new remotely operated vehicles cost about $30,000. Large vehicles to which specialized modular work packages attach, may cost as much as $1 million or more but can combine the attributes and capabilities of several machines.

The preservation community must more systematically and effectively quantify and communicate the benefits and costs of historic preservation to policymakers at all governmental levels. There have been isolated attempts to do so, most notably by the National Park Service, which has kept various statistics since 1976 on rehabilitations to historic structures completed under the preservation tax incentives program.[43] The National Institute for the Conservation of Cultural Property, Inc., with funding from the Design Arts Program of the National Endowment of the Arts, recently published survey findings that attempt to quantify the scope of the Nation's requirements in building conservation. The study provides information for both Congress and private foundations.[44]

It is essential, however, that the Federal Government establish an ongoing, consistent approach to gathering, analyzing, and updating cost/benefit statistics from both the public and private sectors within a central coordinating agency, such as the Department of the Interior or the National Trust for Historic Preservation.

Reducing the overall expense of any historic preservation project requires more knowledge of the capabilities and costs of new technologies. However, some of these costs are not well known or easy to obtain, particularly by cultural resource managers whose need for a greater sense of possible future cost reductions is critical. It is also important that there be central coordination for disseminating information concerning appropriate and expected costs.

For example, the computers used in conjunction with remote sensing technologies are becoming cheaper to manufacture and install as they become more powerful; thus, more and more data can be processed at less cost. For archaeological and landscapes studies, photographic interpretation from aerial photographs usually costs about $2.40 per acre. The costs of a recent NASA/NSF project, using advanced sensors from space and on aircraft, are closer to $0.001 per acre.[45]

Advanced technologies especially benefit the research phases of survey, site identification, and sampling because gathering as much information as possible prior to excavation or detailed site analysis can cut costs. The consultation of records and documentation, such as photographs, maps, and earlier surveys, is especially important in reducing costs as well.

Although the use of new technologies might provide important cost benefits, certain relatively simple technologies are, and will continue to be, effective and economical to apply. On the other hand, if new technologies are not used, installed, maintained, or understood properly, loss of the resource can result. Also, technologies that can be understood, operated, and maintained only by highly trained technicians might have little utility in the field.

Regular Maintenance May Reduce Overall Costs

In many cases, cyclical maintenance properly carried out ultimately provides the greatest cost benefit with respect to the preservation of historic structures and landscapes. One example of loss of a designated historic structure through lack of scheduled maintenance involves the gantry used to prepare the first successful U.S. satellite, the Explorer 1. The structure is scheduled for demolition, having suffered severe deterioration from a highly corrosive coastal atmosphere. At this point, $1.2 million must be spent to repair it; $70,000 per year would be necessary to maintain it thereafter. The gantry had not been painted or otherwise protectively treated for 15 years. Had a regular maintenance program been adopted, the gantry could have been kept structurally sound for only $15,000 per year.[46]

Costs and Economic Values

Important distinctions must be made between cost and value with respect to historic structural preservation. For example, the tax incentives available through the Tax Reform Act of 1976, the Revenue Act of 1978, and the Economic Recovery Tax Act of 1981, as amended, have increased the value, but not the costs, associated with rehabilitation of qualifying older buildings. These incentives, however, do not encourage developers to extend the lives of their improvements beyond 5 years. As long as the preservation tax incentives exist, historic structural rehabilitation and restoration in the private sector will continue in spite of certain high-cost items.

---

[43] "Tax Policy and Administration: Historic Preservation Tax Incentives," GAO/GGD-86-112FS (Washington, DC: General Accounting Office, August 1986).

[44] *Historic Buildings: A Study on the Magnitude of Architectural Conservation Needs in America* (Washington DC: National Institute for the Conservation of Cultural Property, Inc., 1984).

[45] Thomas Sever, National Aeronautics and Space Administration, personal communication, 1986.

[46] *Space World*, May 1986.

In identifying and evaluating the significance of older structures, adequate research involving documents and computer databases firmly establishes the role of a structure within its historic context and increases overall project value, but adds very little to its costs. Advances in computerizing historic preservation databases will eventually reduce research costs.

In evaluating the physical condition of historic structures, accurate assessments prevent costly mistakes, which can easily result from inappropriate, ineffective, and destructive treatments. New technologies are enabling much better diagnosis of structural soundness and can reveal the more subtle or hidden consequences of past preservative actions. While these evaluative techniques may be expensive, their use can mean considerable total project savings.

Recent analyses on "embodied energy" demonstrate how the costs of older buildings expressed in British thermal units (Btu) can justify their continued existence, proving them to be assets far too valuable to destroy. A Department of Energy study[47] showed that in 1967, rehabilitating a structure required only 49,000 Btu per square foot, compared to 65,200 Btu to build the same structure new.

A study sponsored by the Advisory Council on Historic Preservation, using the embodied energy concept, showed that a 1934 housing complex in Indianapolis, should not be razed.[48] It offered a more practical approach toward arguing against the destruction of older buildings. Btu represent for preservationists a potentially powerful tool for deriving qualitative measures of absolute structural value. Some preservationists assert that it should be possible to bank Btu as credits to encourage developers to weigh the costs associated with investing in retaining old structures against demolishing them and erecting new ones.

Reducing Costs in the Marketplace

Suppliers of systems and products must be able to perceive a more substantial market within historic preservation. Preservationists at times have successfully defined and quantified the market for manufacturers, most effectively through the Preservation Tax Incentives Program. The Secretary of the Interior's Standards for Rehabilitation, developed within that program, have communicated to product developers and manufacturers as well as architects and engineers what treatments and techniques are and are not acceptable for the purposes of certification.

As a result, the window manufacturing industry is designing systems that are compatible with historic structures and mini-industries for historic window repair are flourishing. However, only a concerted effort by the various elements within the preservation community to publicize their needs to the business and manufacturing community will achieve greater progress in lowering the high costs of research, development, and production of new conservation technologies.

Developing Additional Support for Preservation

One example of an extremely well-planned funding acquisition strategy from which the preservation community could draw important lessons is being developed for highway research. The Transportation Research Board found that between now and the end of the century there would be a requirement for around $400 billion for highway and bridge construction and upkeep and a vastly improved research effort. The board, with support from the Federal Highway Administration, completed a report entitled "America's Highways—The Search for Innovation," which was widely publicized. On the basis of this report, The American Association of State Highway and Transportation Officials started planning the Strategic Highway Research Program which is to be funded at a level of about $30 million per year for 5 years through a set-aside of .25 percent of the $0.05 Federal gasoline tax. At this point the project seems likely to proceed. Preservationists cannot only learn from such an effort but participate in it as well.

---

[47] Richard G. Stein and Associates, "Energy Use for Building Construction," Center for Advanced Computation, University of Illinois at Champaign-Urbana, no date.

[48] *Assessing the Energy Conservation Benefits of Historic Preservation* (Washington DC: Advisory Council on Historic Preservation, 1979).

Appendixes

Appendix A

Cultural Resources Management Laws and Regulations[1]

Laws

The Antiquities Act of 1906 (Public Law 59-209; 34 Stat. 335; 16 U.S.C. 431-433): provided for the protection of historic, prehistoric, and scientific remains, "or any object of antiquity," on Federal lands; established criminal sanctions for unauthorized destruction or appropriation of antiquities; authorized the President to declare by proclamation national monuments; and authorized the scientific investigation of antiquities on Federal lands, subject to permit and regulations. It required that the parcel of land set aside be "the smallest area compatible with the proper care and management of the objects to be protected."

The National Park Service Organic Act (Act of Aug. 26, 1916, 39 Stat. 535, 16 U.S.C. 1-4): Established the National Park Service. "[It] shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The Historic Sites Act of 1935 (Public Law 74-292; 49 Stat. 666; 16 U.S.C. 461-467): authorized the programs that are known as the Historic American Buildings Survey, the Historic American Engineering Record, and the National Survey of Historic Sites and Buildings; authorized the establishment of National Historic Sites and otherwise authorized the preservation of properties "of national historic or archaeological significance"; and authorized the establishment of museums in connection therewith; authorized the designation of National Historic Landmarks; established criminal sanctions for violation of regulations pursuant to the act; authorized interagency, intergovernmental, and interdisciplinary efforts for the preservation of cultural resources; and other provisions. The first efforts to salvage archaeological data that would otherwise be lost were done under the authorities of this act beginning with the River Basin Survey in 1946.

The National Trust Act of 1949 (Public Law 81-408; 63 Stat. 927): facilitated public participation in the preservation of sites, buildings, and objects of national significance or interest. It created the National Trust for Historic Preservation and empowered it to acquire and hold property for historic preservation purposes; enter into contracts and agreements to further the policies enunciated in the Historic Sites Act; sue and be sued; and perform other lawful acts to carry out the purposes of the National Trust.

The Management of Museum Properties Act of 1955 (Public Law 69 Stat. 242; 16 U.S.C. 18f): commonly known as the Museum Act of 1955, this act authorizes certain management actions to be taken with regard to objects in National Park Service museum collections, including accepting donations or bequests, making purchases from donated funds, making exchanges, and receiving and granting loans of properties.

The Reservoir Salvage Act of 1960 (Public Law 86-523; 74 Stat. 220; 16 U.S.C. 469-469c): indicated further concern with cultural resources recovery and reemphasized the need to recover data. The act provided for the recovery and preservation of "historical and archeological data (including relics and specimens)" that might be lost or destroyed as a result of the construction of dams, reservoirs, and attendant facilities and activities (see also the 1974 amendment to this act).

The Department of Transportation Act of 1966 (Public Law 89-670; 80 Stat. 931): stated in Section 4(f) that the Secretary of Transportation "shall not approve any program or project which requires . . . the use of . . . any land from a historic site . . . unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such . . . historic sites resulting from such use."

The National Historic Preservation Act of 1966 (Public Law 89-665; 810 Stat. 915; 16 U.S.C. 470): declared a national policy of historic preservation, including the encouragement of preservation on the State and private levels; provided authority for the expansion of the National Register of Historic Places to include cultural resources of State and local as well as national significance; authorized matching Federal grants to the States and the National Trust for Historic Preservation for the acquisition and rehabilitation of National Register properties; established the Advisory Council on

---

[1] National Park Service and OTA.

Historic Preservation; provided certain procedures to be followed by Federal agencies in the event of a proposal that might have an effect on National Register properties; defined the term *historic preservation* as "the protection, rehabilitation, restoration, and reconstruction of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, or culture."

The National Environmental Policy Act of 1969 (Public Law 89-665; 80 Stat. 915; 16 U.S.C. 470): declared in Section 101-B(4) that it is the policy of the Federal Government to "reserve important historic, cultural and natural aspects of our national heritage." In order to carry out this policy, the act required an interdisciplinary study of the impacts associated with Federal programs.

Public Law 91-243, May 9, 1970: amended the National Historic Preservation Act of 1966 by extending the funding for the program through 1973, increasing the membership of the Advisory Council on Historic Preservation, and authorizing the participation of the United States as a member in the International Center for the Study of Preservation and Restoration of Cultural Property, and authorized funds for this purpose.

Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 13, 1971 (36 F.R. 8921): instructed all Federal agencies to provide national leadership in historic preservation, to ensure the preservation of cultural properties in Federal ownership, and to "institute procedures to assure that federal plans and programs contribute to the preservation and enhancement of nonfederally owned sites, structures, and objects of historical, architectural, or archeological significance." The order specifically directed all Federal agencies to "locate, inventory, and nominate to the Secretary of the Interior all sites, buildings, districts, and objects under their jurisdiction or control that appear to qualify for listing on the National Register of Historic Places." The order further established procedures to be followed by all Federal agencies pending completion of the cultural resources inventories. The 1980 amendments to the NHPA contained similar mandates for survey and inventory and these guidelines have cited the act rather than the Executive order, where appropriate.

The Archeological and Historical Preservation Act of 1974 (Public Law 93-291; 88 Stat. 174): amended the 1960 Salvage Act, provided for the preservation of significant scientific, prehistoric, historic, or archaeological data (including relics and specimens) that might be lost or destroyed as a result of: 1) the construction of dams, reservoirs, and attendant facilities and activities; or 2) any alteration of the terrain caused as a result of any Federal construction project or federally licensed project, activity, or program. It also required that the Secretary of the Interior be notified of impending loss of such resources, and that the agency or the Secretary may survey and recover the data, then publish the results. It provided for agreement on time limits for initiation and completion of survey and recovery efforts. It required the Secretary to coordinate, report on, consult with experts about, and distribute funds appropriated for this survey and recovery efforts. It provided that up to 1 percent of the total amount authorized to be appropriated for the Federal activities be transferred to the Secretary for implementation of the act, as well as providing for prior compliance with Section 106 of the National Historic Preservation Act of 1966 with regard to properties listed in or eligible for listing in the National Register of Historic Places.

Public Law 94-458; 90 Stat. 1939, October 7, 1976 (90 Stat. 1939): amended Public Law 89-665 (80 Stat. 915; 16 U.S.C. 470(c) by adding a new paragraph as follows: "(4) to withhold from disclosure to the public, information relating to the location of sites or objects listed on the National Register whenever he determines that the disclosure of specific information would create a risk of destruction or harm to such sites or objects." Section 12 of this law required the preparation of general management plans for each unit of the National Park System, including the National Capital Region, and transmittal to the Committees on Interior and Insular Affairs.

American Folklife Preservation Act of 1976 (Public Law 94-201, 89 Stat. 1130, 20 U.S.C. 2101-2107): declared that because American folklife has made such a great contribution to this Nation's cultural richness and sense of individuality and identity, it is therefore the policy of the United States to "preserve, support, revitalize, and disseminate American folklife traditions and arts . . . ." The act also defined American folklife; established the American Folklife Center and described its organization; and authorized the Librarian of Congress to: 1) promote various American Folklife programs; 2) establish, maintain, procure items for, and loan or exhibit items from a national archive and center for American folklife; 3) prescribe regulations; and 4) perform other lawful acts in furtherance of the policies of this act.

Public Law 94-422, September 28, 1976: amended Section 106 of the National Historic Preservation Act to apply to properties eligible for inclusion in the National Register. Additional funding was appropriated to carry out the provisions of the act; the organization of the Advisory Council was clarified, and the membership expanded to 29 members. The council was established as a fully independent agency within the executive branch and authorized to promulgate rules and regulations it deems necessary to implement Section 106.

The American Indian Religious Freedom Act, August 11, 1978 (Public Law 95-341): provided that it is "the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including, but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonial and traditional rites."

The Archaeological Resources Protection Act of 1979 (Public Law 96-95; 93 Stat. 712, 16 U.S.C. 470): provided for the protection of archaeological resources located on public lands and Indian lands; defined archaeological resources to be any material remains of past human life or activities that are of archaeological interest and are at least 100 years old; encouraged cooperation between groups and individuals in possession of archaeological resources from public or Indian lands with special permit and disposition rules for the protection of archaeological resources on Indian lands in light of the American Indian Religious Freedom Act; provided that information regarding the nature and location of archaeological resources may remain confidential; and established civil and criminal penalties, including forfeiture of vehicles, fines of up to $100,000, and imprisonment of up to 5 years for second violations for the unauthorized appropriation, alteration, exchange, or other handling of archaeological resources, with rewards for furnishing information about such unauthorized acts.

Archaeological resources covered by the Antiquities Act of 1906 are covered by this act. A valid permit issued under the Antiquities Act before the date of this act remains in effect according to its terms and conditions; therefore, no new permit is required. A permit issued under this act takes the place of a permit under the Antiquities Act. Nothing in this act shall apply to any person who was in lawful possession of an archaeological resource prior to the date of this act.

National Historic Preservation Act (amended 1980) (Public Law 96-515; 94 Stat. 2997): expanded the roles of Federal, State, local, and private sectors, and provided important new mandates for Federal land managers in the area of historic preservation. The act directs the Secretary to implement regulations establishing uniform processes and standards for documenting historic properties included in the Library of Congress records; requires each Federal agency to establish a program to locate, inventory, and nominate to the National Register all properties under the agency's control; directs each Federal agency to exercise caution so that properties that may be eligible are not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate significantly; and establishes a higher standard of care for National Historic Landmarks. After appropriate consultation with the Advisory Council on Historic Preservation, an agency may lease its historic property if such lease will adequately ensure the preservation of that property. The proceeds of the lease may be retained by the agency and used to defray administrative, maintenance, repair, and related expenses incurred by the agency in the use of the property or other properties listed on the National Register and under the ownership or control of such agency. The act also changes the number of members on the Advisory Council on Historic Preservation; directs the Secretary's participation in the development of the World Heritage List and the Convention Concerning the Protection of the World Cultural and Natural Heritage; and allows agency heads to withhold information relating to location of historic resources after consultation with the Secretary.

Regulations

Regulations are promulgated, adopted, and then compiled in the Code of Federal Regulations (CFR), in order to implement provisions of general laws. The name of the act it implements follows each CFR citation below.

43 CFR 3 (Antiquities Act), "Proposed Rule: Preservation of American Antiquities" defines "objects of antiquity" in relation to the Antiquities Act of 1906, in terms of objects of archaeological, anthropological, paleontological, or historical interest.

43 CFR 7 (Archaeological Resources Protections Act of 1979) "Final Rule: Protection of Archaeological Resources: Uniform Regulations," it establishes governmentwide policy for additional regulations by which agencies protect federally owned archaeological resources through permits for authorized excavation and through civil penalties for unauthorized excavation, removal, or damage. It also allows information about the location of archaeological resources to be kept confidential where disclosure of such information may threaten the resource.

36 CFR 60 (NHPA and EO 11593), "Procedures for Approved State and Local Government Historic Preservation Program" establishes the standards for the Secretary's approval of State historic preservation programs, and requires State Historic Preservation Officers to conduct a statewide survey of cultural properties, to prepare and implement a State preservation plan, and to cooperate with Federal agencies in their compliance with the provisions of Section 106 of the National Historic Preservation Act (see 36 CFR 800). In addition, 36 CFR 61 provides for local government certification to participate in the Federal preservation program, and establishes standards for the qualifications of professionals in the preservation field.

36 CFR 63 (NHPA and EO 11593) entitled "Determinations of Eligibility for inclusion in the National Register of Historic Places," codified the process through which Federal agencies request and obtain a determination of properties' eligibility for inclusion in the National Register of Historic Places.

36 CFR 65 (Historic Sites Act of 1935) "National Historic Landmarks Program" establishes procedures to identify cultural resources of exceptional national significance, to designate them, and to encourage their owners to preserve and protect them. It also provided for revising boundaries of National Historic Landmarks and removing a landmark designation.

36 CFR 66 (Archaeological and Historic Preservation Act of 1974) "Proposed Rule: Recovery of Scientific, Prehistoric, Historic, and Archaeological Data: Methods, Standards, and Reporting Requirements," it establishes guidelines and standards for data recovery from cultural resources important primarily for their research potential. It also covers qualification of professionals carrying out work, the content of the recovery program, the curation of data and materials retrieved, and directions for filing reports on data recovery with the Department of the Interior.

36 CFR 68 (NHPA) contains the Secretary of the Interior's standards for historic preservation projects, including standards for acquisition, protection, stabilization, preservation, rehabilitation, restoration, and reconstruction.

36 CFR 800 (NHPA and EO 11593), "Protection of Historic and Cultural Properties," includes the regulations published by the Advisory Council on Historic Preservation to implement Section 106 of the National Historic Preservation Act, as amended, and two Presidential directives issued pursuant to Section 106 (EO 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment," and the President's Memorandum on Environmental Quality and Water Resources Management, July 12, 1978). The regulations were amended March 1, 1979, to reflect changes and additions to the Advisory Council's authorities, as well as experience gained in working with the process since the last publication of regulations in 1974. These amendments are intended to expedite and clarify the commenting process required by Section 106 of the NHPA and Section 2(b) of Executive Order 11593 for a particular program or class of undertakings that would otherwise require numerous individual requests for comments under these regulations.

40 CFR 1500, "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act," was published by the Council on Environmental Quality as directed by Executive Order 11991 to "make the environmental statement more useful to decision makers and the public; and to reduce paper work and the accumulation of extraneous background data, in order to emphasize the need to focus on real environmental issues and alternatives." The regulations require all agencies to adopt procedures which ensure, among other things, that environmental information is available to public officials and citizens before actions are taken. Although separate from NEPA, the responsibilities of the National Historic Preservation Act and Executive Order 11593 are to be complied with using these same procedures.

Appendix B

Documentation and Conservation of Rock Art

Images that have been painted or carved on rock surfaces convey important cultural information, both from prehistoric and historic eras. In the United States, most rock art designs[1] were executed by Native Americans before contact with western civilization.[2] However, numerous examples exist of historic rock art that convey important information about the exploration and settlement of North America by Euroamericans. Perhaps the most famous and striking examples are the numerous inscriptions recording the passage of Spanish explorers between 1605 and 1774[3] on the sandstone at El Morro National Monument, east of Zuni Pueblo in central New Mexico. There, the signatures of individuals from 28 different groups of explorers share the rock surface with images carved or pecked hundreds of years earlier by ancestors of the Zuni Indians.[4]

Rock art images are especially important in understanding the lives of prehistoric Native Americans, who left no written record of their activities. Nevertheless, although scholars in many disciplines, as well as native peoples themselves, have long recognized the importance of documenting and analyzing Native American rock art, it has been frequently neglected.

Documentation of Rock Art

Because it has been so long neglected, the study of rock art is still largely descriptive. Thus, the identification and documentation of rock art is extremely important. Individuals and groups interested in this form of cultural expression, many of them amateurs, have contributed greatly to our awareness of the extent of the resource. For example, professional and amateur members of the American Rock Art Research Association and the Canadian Rock Art Research Associates have devoted countless hours of time to recording North American rock art, and have developed considerable expertise in conserving rock art.[5] Yet their documentation techniques are often idiosyncratic and inconsistent. Such techniques have not received sufficient study nor, until recently, has there been an effort toward developing consistent, objective, universally applicable methods of documentation and recording.[6]

- **Site forms.**—An important part of standardizing the recording process is developing site recording forms that are consistent with rock art forms used in other locations and with more general archaeological site forms. Portable computers could make the recording of field data more accurate and complete. The recording form itself can be stored in the computer and appropriate information supplied in response to prompting from the computer.
- **Drawings, photographs and other two-dimensional recording methods.**—*Photography* is the most common method of documenting rock art today. However, it suffers from the drawback that many shallowly pecked or carved images are difficult to see when the lighting strikes perpendicular to the stone face. Researchers have tried a variety of methods of recording the details of such images, including using oblique artificial lighting, high contrast film, and infrared film.[7] They have also tried enhancing the images with chalk, water, and aluminum powder suspended in water. None of these latter methods can be recommended because they may damage the rock art design or affect the local environment adversely.[8]

Drawings and paintings have also been used. Faded and eroded pictographs present particular problems of documentation. One important technique for recording such paintings is to reproduce them in watercolors or oils. The Texas artist Forrest Kirkland recorded thousands of painted images in the rock shelters and caves of Texas.[9] He chose watercolor, because watercolor board is suitable for pencil drawings and because the watercolor can be applied quickly and easily compared to the original. In addition, watercolor board can be transported and stored relatively easily. Archival watercolor board and paints provide a near permanent record. However, such methods require a skilled artist and are time-consuming. In addition, they do not convey the character and condition of the rock surface, and are not necessarily done to scale. They also do not reproduce the three-dimensional quality of many rock art panels, which is an integral component of the rock art image.

---

[1] "Rock art . . . includes petroglyphs (designs pecked, scratched, abraded or otherwise cut into cliffs, boulders, bedrock, or any natural surface), and rock paintings (designs painted in similar locations). It does not include . . . designs formed by rock alignments on the ground." See Polly Schaafsma, "Form, Content, and Function: Theory and Method in North American Rock Art Studies," *Advances in Archaeological Method and Theory* 8, 1985, p. 237.

[2] For general surveys see, for example, Campbell Grant, *Rock Art of the American Indian* (New York: Thomas Y. Crowell Co., 1967); or Klaus Wellman, *A Survey of North American Indian Rock Art* (Graz, Austria: Akademische Druck and Verlagsanstalt, 1979).

[3] Evon Z. Vogt, "El Morro National Monument," *El Palacio* 12, 1922, pp. 161-168.

[4] M. Jane Young, *Signs From the Ancestors: Zuni Cultural Symbolism and Rock Art* (Albuquerque, NM: University of New Mexico Press, in press).

[5] In New Mexico, field schools run by Colonel James Bain over the past two decades have contributed thousands of records of New Mexico rock art, which are maintained at the Laboratory of Anthropology of the Museum of New Mexico. The Massachusetts based Earthwatch has devoted a number of its projects to recording rock art in North America.

[6] David R. Stuart, "Recording Southwestern Rock Art Sites," *The Kiva* 43, 1978, pp. 183-199.

[7] James B. DeKorne, "How To Photograph Rock Art," *El Palacio* 77, 1970, pp. 14-17; Grant, op. cit., pp. 68-73.

[8] Chalk tends to abrade the stone and distort the original image. Water may wash away mud or pigment applied by the artist. Aluminum powder, though it washes off after drying, requires a water rinse that may remove mud or pigment, and then becomes mixed with the local soil.

Rubbings and tracings may be used to good effect for petroglyphs under certain conditions.[10] They have the advantage that it is possible to record the roughness of the rock surface, but the disadvantage that such methods are extremely time-consuming. When supplemented with photography, rubbings or tracings can produce accurate and pleasing records of petroglyphs.

Stereo photogrammetry.—This is a superior method that allows the rock art to be recorded in relation to its surroundings.[11] Later analysis of the stereo photographic pairs allows three-dimensional reconstruction of a rock art site, which can be critical in interpreting the meaning and function of the images.

Molds.—A number of these techniques have been tried for petroglyphs that are deeply cut, but all are extremely time-consuming, and are therefore generally not satisfactory as a means of recording images. They are also difficult to store. Plaster, wax, or latex reverse molds have been tried on small areas. Such methods are most useful when interpretive displays of rock art are contemplated.

Dating of Rock Art

No methods currently exist for directly establishing dates of rock art images. Methods so widely used for dating archaeological artifacts are generally inapplicable for rock art. For example, traditional radiocarbon dating methods are inappropriate for charcoal drawings because they require too large a sample. Dating the image would destroy it. In the absence of any absolute methods, rock art researchers have therefore relied on a variety of relative methods to date rock art: differential weathering, relative patination, superimposition of one image over another, style, content, and the relationship of images or panels of images to datable material.[12] None of these techniques is very satisfactory, for even in relative terms, they provide only a very broad gauge of the age of a rock art panel (i.e., within 50 or 100 years).

Rock art research would gain immeasurably by the development of direct dating techniques. Methods that have been tried include measuring the depth and extent of lichen growth over rock art images, thickness of mineral deposits (so-called desert varnish), and X-ray fluorescence. However, none of these methods have proved successful.[13]

For example, one method that has been tried with inconclusive results is the measurement of the concentration of hydrogen v. depth in petroglyphs. Most newly exposed surfaces of rock bearing silicates will take up water from the atmosphere. The amount of hydrogen is directly proportional to the amount of water in the micro layers of the rock surface. Newly exposed surfaces should exhibit a hydrogen profile (percentage of hydrogen plotted against depth) markedly different from much older surfaces. However, in using a method originally developed to measure hydrogen profiles of lunar rocks, scientists found that the hydrogen profiles they measured from different petroglyph samples were highly variable. "At present there seems little possibility of reliably chronologically ordering prehistoric glyphs using this method."[14]

The challenge in dating rock art will be to develop nondestructive methods. New radiocarbon methods that require only minute amounts (micrograms or smaller) of carbon material may eventually be applied to dating images containing organic pigments with success.[15]

Information Storage

Currently, efforts are underway to standardize recording forms and procedures so that all of the relevant information pertaining to a rock art site and its images can eventually be stored in a central database. However, such efforts generally assume that rock art imagery can be labeled unambiguously and in terms that transcend cultural boundaries. Recent advances in optical disk technology may make it possible to store and retrieve the actual image rather than a label describing it.

---

[9] W.W. Newcomb, Jr., *The Rock Art of Texas Indians* (Austin, TX: University of Texas Press, 1967).

[10] Phyllis Hughes, "How To Make Rubbings of Rock Art," *El Palacio* 77, 1970, pp. 18-24.

[11] The application of this method is described in the report by Solveig Turpin, "Seminole Canyon: the Art and the Archeology," *Texas Archeological Survey Report* 83 (Austin, TX: University of Texas, 1982). See also Solveig Turpin, et. al., "Stereophotogrammetric Documentation of Exposed Archaeological Features," *Journal of Field Archaeology* 6, 1979, pp. 329-337.

[12] For example, in the Southwest United States some rock art panels exist on the canyon wall immediately above the former roof of a ruined Pueblo Indian dwelling. If the pueblo can be dated by means of tree rings or other methods, the archaeologist can estimate the rock art dates.

[13] Schaafsma, op. cit., p. 243.

[14] R.E. Taylor, "Potential Use of Hydrogen Profile Analysis To Date Petroglyphs at the Hedgepeth Hills Site: A Feasibililty Study," in J. Simon Bruder, "Archaeological Investigations at the Hedgpeth Hills Petroglyph Site," *Museum of Northern Arizona Research Paper* 28, app. IV.

[15] Christopher Chippendale, "Radiocarbon Comes of Age at Oxford," *New Scientist*, July 21, 1983, pp. 181-184.

Interpretation of Rock Art Images

Many early attempts to interpret rock art failed because investigators lacked broad additional knowledge of the cultures from which it derives. In addition, rock art had not yet been widely documented. However, research during the last decade has demonstrated the importance of rock art studies to understanding prehistoric cultures in the United States. The evidence provided by rock art has, among other things, demonstrated the prehistoric movement of religious ideas along the Rio Grande from Mexico to northern New Mexico,[16] provided insights into Native American astronomical methods,[17] and furnished evidence of prehistoric amputation practices.[18] In California, studies of Chumash Indian rock art have led to a much deeper understanding of Chumash philosophy and sacred practice.[19]

Stereophotogrammetry can provide the accurate environmental context for rock art sites; the cultural context must be provided either by ethnohistorical or archaeological research. In the case of Native American rock art, tribal commentary on recent images is crucial to understanding and interpreting them. It is particularly important that Native American cultural attitudes towards the landscape be included in this interpretive process.

Public interpretation is especially important as greater awareness of the fragility of rock art and of the role this cultural resource can play in understanding Native American culture can lead to more effective conservation.

Conservation and Protection

U.S. rock paintings and carvings, like the cave paintings of Lascaux, France or Altamira, Spain, are subject to many different destructive agents (table B-1 and table B-2). Individuals have used a variety of methods in attempts to conserve and protect rock art. Such efforts are aided by a generally supportive attitude on the part of local residents. However, slow deterioration through weathering and quick destruction from vandalism or local development remain serious threats. In some areas, fences or gratings have been used to prevent observers from reaching rock art. Yet such devices would be much too costly for most areas, and inappropriate for others. Most are unsightly.

Table B-1.—Agents Contributing to Rock Art Deterioration and Destruction

Natural agents:
Bacteria
Direct contact with water
Exfoliation of stone (water, salts, changes of temperature, and humidity)
Insects
Joints and cracks
Lichen
Surface accretion
Vegetation
Wind abrasion

Human agents:
Development
Vandalism:
  Bullet holes
  Etched graffiti
  Paint graffiti

SOURCES: Office of Technology Assessment and Constance S. Silver, *The Rock Art of Seminole Canyon State Historical Park: Deterioration and Prospects for Conservation* (Austin, TX: Texas Parks and Wildlife Department, February 1985).

In addition, some threatened sites are still visited regularly by Native Americans for religious purposes. The Zuni Indians, who live in New Mexico, for example, "regard many of the rock art images on their tribal lands as a link with their mythological past, as 'signs from the ancestors'; hence, they are particularly worried about vandalism and the deterioration of images through time."[20] Other sites, though they are no longer visited, may have played an important role in Native American history and are therefore considered sacred. In designing policies to protect such sites, it is crucial to consider how preservation efforts fit within the Native American cultural context.[21]

---

[16] Polly Schaafsma, *Indian Rock Art of the Southwest* (Albuquerque, NM: University of New Mexico Press, 1980), ch. 8; Polly Schaafsma and Curtis F. Schaafsma, "Evidence for the Origins of the Pueblo Katchina Cult as Suggested by Southwestern Rock Art," *American Antiquity* 39, 1974, pp. 535-545.

[17] See, for example, Arlene Benson and Tom Hoskinson, *Earth and Sky: Papers From the Northridge Conference on Archaeoastronomy* (Thousand Oaks, CA: Slow Press, 1985); or Ray A. Williamson, *Living the Sky: the Cosmos of the American Indian* (Boston, MA: Houghton Mifflin, 1984).

[18] Klaus F. Wellmann, "New Mexico's Mutilated Hand: Finger Mutilation and Polydactylism in North American Indian Rock Art," *Journal of the American Medical Association* 219, 1970, pp. 1609-1610.

[19] Campbell Grant, *The Rock Paintings of the Chumash: A Study of a California Indian Culture* (Berkeley, CA: University of California Press, 1965).

[20] M. Jane Young, "Images of Power and the Power of Images: The Significance of Rock Art for Contemporary Zunis," *Journal of American Folklore* 98, 1985, pp. 3-48.

[21] The managers of Kakadu National Park, in Australia, have achieved considerable success in involving the Aborigines in designing the park, and have adopted a set of management principles that "recognise the special relationship that Aborigines have with their land. For them it is an ordered and named landscape full of mythological significance and spiritually dangerous places where delicate religious associations can be disrupted if someone unwittingly trespasses into such sacred sites." See Clive Gamble, "The Artificial Wilderness," *New Scientist*, Apr. 10, 1986, p. 51.

Table B-2.—Weathering Agents Found in Deserts and Cities

Kind of weathering	Desert	Cities
Damaging agents:		
Moisture from condensation	present	present
Moisture from fog	fog in winter	frequent
Moisture from ground	high	high
Salts, origin of salts	desert floor, residual	groundwater, stone
Temperature contrasts	high	high (on walls)
Damage to stone:		
Abrasion by wind action	strong	some, near street level
Desert varnish and stains	hard brown crusts	light-brown stains
Efflorescence	strong	moderate but common
Flaking by heat and moisture	very strong	moderate
Frame weathering, case hardening	common as pebbles	hollow common
Frost action	occasional	high
Solution	very slow	very rapid in polluted atmosphere
Subflorescence	strong	moderate to strong

SOURCES: Constance S. Silver, *The Rock Art of Seminole Canyon State Historical Park: Deterioration and Prospects for Conservation* (Austin, TX: Texas Parks and Wildlife Department, February 1985); and E. Winkler, *Stone: Its Properties and Durability in Man's Environment* (New York: Springer-Verlag, 1975).

Many of the processes active in deterioration of rock art are similar to those causing destruction of stone in urban environments: condensation of moisture, dissolution and recrystallization of salts, and the effects of wide temperature swings as a result of solar heating. For example, Silver[22] has found that many of the processes leading to deterioration of limestone (and therefore to the paintings on the limestone base) in Seminole Canyon State Historical Park are identical or analogous to those found in urban environments. The conservation of rock art can therefore benefit from more general stone conservation efforts. In addition, the conservation of American rock paintings can benefit from the research that has been applied to the cave paintings in Europe,[23] and to Aboriginal paintings in Australia.[24]

In spite of the extent of this resource, no conference primarily devoted to the conservation of rock art has ever been held in the United States. Efforts to share information on conservation have largely occurred on an ad hoc basis.

Because not every rock art panel or image can be preserved, some effort should be devoted to deciding which areas have the most critical need. One of the difficulties in making such choices is that until more research is done, it will be impossible to determine which rock art panels have the greatest significance. One of the critical areas for attention to the preservation of rock art are the rural fringes of urban areas. As urban development spreads out into the countryside, it has begun to affect the preservation of rock art in some areas.[25]

---

[22] Constance S. Silver, *The Rock Art of Seminole Canyon State Historical Park: Deterioration and Prospects for Conservation* (Austin, TX: Texas Parks and Wildlife Department, February 1985).

[23] P. Mora, L. Mora, and P. Philippot, *La Conservation des Peintures Murales* (Rome: International Center for Conservation, 1977).

[24] J. Clarke "Conservation and Restoration of Painting and Engraving Sites in Western Australia," *Conservation of Rock Art* (Canberra: I.C.C.M., 1978.

[25] For example, rock art on the West Mesa west of Albuquerque, NM, is threatened by housing development. Concerned individuals have formed a group named Friends of the Albuquerque Petroglyphs (FOTAP) to protect an estimated 10,500 petroglyphs, executed on basalt outcroppings. In addition to calling attention to the problem in the media, FOTAP has organized educational tours of the threatened rock art, and is documenting all of it. See "Save the Petroglyphs" (editorial), *Albuquerque Tribune*, Apr. 17, 1986, p. A-14.

Appendix C

Registration and Private Ownership of Archaeological Objects[1]

Archaeologists and Collectors

Archaeologists have always approached the problem of the long-term care and administration of the objects we recover and study from conflicting points of view. Though we insist on the most careful methods for recovering, documenting, and studying artifacts, we often reject the responsibility for their care after they have served our immediate ends.

Yet many archaeologists become outraged by the hoards of artifact collectors who buy and sell objects and who wish, more than anything else, to provide long-term care to the objects they acquire. The collector, on the other hand, appears to reject the responsibility for obtaining and preserving the contextual, descriptive data that is so important to archaeological research and an understanding of the past. The collector wants the object for its beauty, unusual qualities, or for its market value.

The archaeological community considers the purchase and sale of objects and the looting of archaeological sites that generally predeeds them an abomination, yet refuses to deal with the causal factors that underlie the destructive nature of the activity. Some sectors of the archaeological community have attempted to wage a legislative war with the collector. They seem to have had little effect on the continuing distruction of archaeological properties. In my estimation, the archaeological community cannot expect to win a war with the "art" collecting public. As long as archaeological properties have value to people, they will continue to attempt to purchase them, whether they are obtained legally or illegally, thus creating a demand for illegal pothunting. Archaeologists, then, have everything to gain from a negotiated truce, but a lot to lose if we choose to ignore the collector's interest in acquiring and caring for archaeological objects.

The following discussion lays out the groundwork for one possible settlement between archaeologist and collector. The settlement provides the archaeologist with information and the collector with artifacts.

A Look At The Real World

Let us examine the real case of an individual who may own property containing an archaeological site. The landowner can:

- leave it alone;
- dig it up, and either sell or keep any artifacts;
- approach archaeologists to dig it up, allowing them to retrieve both the objects and the information;
- donate the site to the Archaeological Conservancy or some other nonprofit institution; or
- sell the contents of the site to someone else to dig up on speculation.

Before choosing an option, the landowner must evaluate his or her motivations, which are one or a combination of the following:

- financial gain;
- building a collection for personal enjoyment;
- curiosity or "adventure";
- public service or a desire to "do the right thing"; and
- legal and/or public pressure to leave the site undisturbed.

If the landowner's motivations are public spirited, the site either remains undisturbed or is mined for information as well as artifacts. In either case, the archaeological community's research interests are forwarded. If recovered, the artifacts then enter into a grey area of ownership, but are often placed under the stewardship of the presiding archaeologist, a university, or an institute. Very often, they simply drop out of sight.

If the landowner's motivations are driven solely by personal enjoyment or for financial gain, archaeologists lose. The landowner has contributed to his own or someone else's collection without gathering the essential contextual information. Because the methodology for pure artifact extraction differs from the methodology for research, only the "goodies" get passed on. In today's climate, the site owner recognizes no options in excavating if driven by the desire to gain a collection or to gain financially because the archaeological community is largely unapproachable. The data, for all practical purposes, have been given up.

---

[1] This paper was requested from Dr. Walter Wait, archaeologist, after an intensive discussion with OTA staff concerning technology and protection of archaeological properties. Although this paper focuses on a partial solution the loss of prehistoric archaeological remains, much of the discussion is also applicable to such historic cultural material.

Inserting the Archaeologist Into the Collector's Loop

Because the prehistoric or historic culture of the country is at stake, we might ask what we can offer the collector in return for the opportunity to gain a deeper understanding of the site and the people who created it. Perhaps the one thing that the archaeological community has of value to the collector is the academic credentials that permit the validation of an object's authenticity. "Genuineness" is of critical importance to a collector of objects. One of the few times an archaeologist and a collector come face to face is when the collector requests assistance in establishing the authenticity of an artifact that he or she has acquired. More often than not, the collector is turned away, widening the gap between the two sides. However, if this is the bargaining chip that archaeology can bring to the negotiating table, it should be used. I propose to trade an offer of authenticity for the careful recovery of associated archaeological data.

In order to offer the collector some document attesting to the provenience of artifacts dug on private land, I suggest that we license archaeologists to supervise the work. This guarantees authenticity and allows the archaeologist to gather important research data.

The Licensed Archaeologist

With an archaeologist on board, the treasure hunt turns into an archaeological dig, the purpose of which is to provide the landowner with collectable, documented artifacts and the archaeological community with data on the artifacts, contextual information, artifact preservation, and professional documentation and reporting.

The site owner now has four options with regard to the conduct of the excavation design:

1. dig where i tell you;
2. dig as much as you can for X dollars;
3. dig where you think you will find collectable artifacts; and
4. dig where you will learn the most.

The archaeologist, according to a standard contract signed by both archaeologist and site owner, would work out an excavation plan designed around the owner's desires as stated above and the number of people hired, conscripted, or otherwise obtained to do the work. The archaeologist's design and subsequent supervision follows a pattern laid down by the professional licensing body. This pattern would include, but would not be limited to the following:

- the excavation will follow standard archaeological principles;
- the excavation will be fully documented with a site map, profile drawings, photos, and excavation locations;
- all artifacts will be recovered and cataloged; and
- a site excavation report will be prepared.

The standard contract might stipulate that the archaeologist will forward registration papers and a certificate of excavation to some National or State registry center. All other recovered remains, artifacts, and samples would become the property of the licensing organization. This group or groups would then be responsible for the curation, protection, or disposal of the site's recovered unregistered remains.

The Registered Artifact

This proposal requires the creation of one or more formal artifact registries. The contracted, licensed archaeologist submits the paperwork to the registry applying for formal approval of the artifact's "pedigree." Paperwork required might be as follows:

- a request for title, which includes a full description, measurements, and a color photograph or digital image;
- a copy of the excavation report;
- a certificate of excavation indicating that a licensed archaeologist was responsible for the excavation or recovery of the object;
- a certified appraisal; and
- a percentage fee based on either the appraised value or the actual sale price.

Upon entry into the registry, the owner would obtain a nontransferable title and an artifact documentation card similar to a plastic driver's license, complete with photo (figure C-1).

Why Do It?

The registration of artifacts requires a great deal of organization and effort. Why should it be done? First, it fulfills the archaeologists' part of the bargain with the collectors—documentation for authentification. The collector receives an artifact with a verifiable history and a title illustrating a valid transfer of ownership. This title, together with accompanying documentation, should increase the value and desirability of the registered artifact. If the registry is current, a prospective buyer could check the title at the registry for verification of the owner of record. Collectors dislike

Figure C-1.—Artifact Title

Name ______________________
Address ______________________
Phone ______________________
Site Number ______________________
Location: 1/4 section __________
county ______________
Excavator's name __________
Site report title __________
____
Permit number ______________

Artifact number ______________
Artifact type ______________
Condition ______________
Culture ______________
Period ______________
Type ______________
Location ______________
Level ______________
Depth ______________
Associated artifacts ________
____
Map with location provided?--
Site report provided? ________
Photograph provided? ________
Date of discovery __________
Date of application ________
Signature:
owner ______________
excavator ____________

forgeries. We could expect that eventually registered artifacts will become the only artifacts worth collecting. This could have the beneficial effect of drying up the market for illicitly obtained objects. If an artifact is not titled, one must assume that it has been unlawfully obtained.

The archaeological community and the public may benefit in several important ways. First and foremost, data collection and preservation are assured. The contract could also give the State or Federal government a right of first refusal to purchase significant artifacts at the appraised value. Furthermore, the registration, being non-transferable, must be applied for each time the artifact's ownership is transferred. The resultant fees could be used to support the registry in several ways:

- support of the registry programs;
- administration and conservation of nontitled artifacts and site documents;
- archaeological research support; and
- archaeological site conservation.

The initial title fee and all transfer fees would support the registry, the duplication and preparation of paperwork, and site documentation and the creation and transmission of curation reports (i.e., papers on how best to protect, care for, conserve, and display specific classes of registered artifacts). Some portion of the fee might go to the curation and care of the artifacts, notes, and specimens recovered from the sites and turned over to the agency for protection. Some funding might go toward promoting research on the recovered material (i.e., requests from licensed archaeologists for subsidies for dendrochronological or other research-oriented analysis). Finally, some funding might go to nonprofit institutions dedicated to the purchase and preservation of intact archaeological properties.

If the excavation does not turn up anything of monetary value, the archaeologist would still submit the certificate of excavation and the excavation report, samples, and artifacts, to the Registry. All recovered material would become the responsibility of the agency. The site owner would have lost his or her speculative investment, but would have the important satisfaction of having contributed to the advancement of knowledge, for the archaeological community would have recovered its interpretive data intact. Since the location of all registered artifacts could be tracked, professional needs to re-study, bring together, or study titled materials, could always be met.

Flaws In the Plan

The plan as outlined has two basic flaws. First, the cost of archaeological excavation is quite high, especially when compared to the usual pothunting techniques. Second, there is already a large inventory of artifacts that must be curated.

Current personnel costs alone for planning and supervising a 1-week excavation, mapping and caring for artifacts, and writing up the report total approximately $3,000, assuming a contract cost of $200 per day. Most excavations are likely to take much longer and require hiring more than one individual. How are the archaeologists to be paid for their efforts? Put another way, how do we fund this collection of data, as opposed to the recovery of objects only. The landowner will probably not be able to fund the excavation effort out-of-pocket. The following options present ways in which the excavation could be funded.

Investor Funding

Speculative funding would require the organization of a group of collectors/investors willing to share the cost of what could be essentially construed as a treasure hunt, but conducted under controlled archaeological conditions.

Tax Incentives

Tax incentives might be provided to a site owner permitting the deduction of archaeological expenses incurred during legitimate site excavations. Contracted archaeological expenses could be considered as a legitimate business expense and could be claimed as a loss should no artifacts of value be recovered.

Subsidies

Federal or State subsidy of archaeological work, where upon application for a subsidy, perhaps to a State Historic Preservation Office, the site owner agrees to pay some portion of the excavation costs on a sliding scale dependent on the appraised value of recovered registered artifacts. The more value actually recovered, the less subsidy the landowner would receive.

Offices

County archaeological offices, similar to the county agricultural agent, could support archaeologists whose primary function would be to supervise excavations on private lands. The government might pay the cost of salary and office space. Site owners would pay the actual material costs of excavation and travel.

Volunteer Field School

Here, "field school" participants would pay for the privilege of excavating the privately owned site, much as they do in a number of nonprofit institutions. The participants would pay fees that would go toward supporting the contracted archaeologist/supervisor.

Traditional Research Grants

As ownership of artifacts recovered on private lands has never been in doubt in this country (they belong to the landowner), the relationship of research and research projects to private landowners remains the same. Some landowners may wish or require principle investigators of research projects to prepare title documents to specific artifacts that the owner wishes to retain.

Nontraditional Grant Programs

Private industry may provide funding for the excavation of sites on private land they own for the tax deduction that such charitable gifts may realize.

The Existing Artifact

If registered artifacts cause the trade in unregistered artifacts to decline, those with unregistered artifacts might be tempted to forge registration certificates, or to "find" their artifacts in new excavations. In order to cope with the existing open market artifacts, an "undocumented" register classification should be created for a short period of time. This would be similar to "foundation stock" accepted in horse and other animal registries. The "undocumented" category would serve to build the register's initial funding base. The initial registration fees might be increased if an artifact owner fails to register the artifact recovered during a legitimate excavation after a certain period of time. This may discourage fraudulent acts (i.e., "seeding" of archaeological sites).

Museums faced with vast surplus collections might title artifacts excavated 20, 30, 40 years ago and place them on the open market, providing that a licensed archaeologist is willing to accept the existing documentation claims provided by the museum, college, or collection. Such an action might enable them to earn needed extra income and help contribute to the acceptance of registration among collectors.

The Registration Mechanism

The National Park Service has just finished developing a computerized National Catalogue for Objects. This catalog program can run on microcomputers as well as mini and mainframe computer systems. Additional work, adding the "transfer of ownership" portions, etc., might turn this National Catalogue into a National Registry that could be handled by individual State offices, or by the Federal Government. State or local registries could be combined to form a national registry where transfer of title could occur anywhere in the United States. The laminated plastic ID card and digitized image of each object are within current levels of technology.

Conclusions

The above scenario, negotiating a compromise between the archaeological community and the public collector, illustrates the potential management of some portion of our artifactual heritage in a nontraditional manner—curation by the collector. The option of first refusal permits the States and Federal Government to obtain for the public any "crown-jewel" that might be uncovered. The registration process permits perpetual tracking of significant artifacts so that museum exhibitions and scholarly research could be carried out.

The compromise as illustrated appears to benefit both parties. Mechanisms for funding, plus the willingness of both sides to go along, however, will be needed if this or any other kind of alternative preservation program is to work. One thing is very clear. Trying to legislate away the art and artifact collector will not curb the desire to own collections. Collecting is a strong part of our culture, both in this country and abroad. Providing alternative means to own and traffic in antiquities may help reduce pothunting and the resultant destruction of important archaeological information. The public and archaeologist could both benefit.

Appendix D

National Register Criteria From the Introduction to:

"How To Apply the National Register Criteria for Evaluation"[1]

As the official list of properties significant in American history, architecture, archaeology, engineering, and culture, the National Register of Historic Places was designed to be used by the general public, local communities, State governments, and Federal agencies in their preservation planning efforts. Properties listed in the National Register receive a limited form of protection and certain benefits. For information concerning the effects of listing, write the National Park Service or any of the historic preservation offices in the States and territories.

Criteria for Evaluation

The criteria are the National Register's standards for evaluating the significance of properties. The criteria are designed to guide the States, Federal agencies, the Secretary of the Interior and others in evaluating potential entries (other than areas of the National Park System and National Historic Landmarks) for the National Register.

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. that are associated with events that have made a significant contribution to the broad patterns of our history; or
B. that are associated with the lives of persons significant in our past; or
C. that embody the distinctive characteristics of type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
D. that have yielded, or may be likely to yield, information important in prehistory or history.

Criteria Considerations

Ordinarily cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

A. a religious property deriving primary significance from architectural or artistic distinction or historical importance; or
B. a building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or
C. a birthplace or grave of a historical figure of outstanding importance if there is no other appropriate site or building directly associated with his productive life; or
D. a cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or
E. a reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or
F. a property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own historical significance; or
G. a property achieving significance within the past 50 years if it is of exceptional importance.

---

[1] Washington, DC, for the Department of the Interior, National Park Service, June 1984.

Appendix E

National Register of Historic Places Inventory—Nomination Form

1. Name

historic

and or common

2. Location

street & number ___ not for publication

city, town ___ vicinity of

state code county code

3. Classification

Category
- ___ district
- ___ building(s)
- ___ structure
- ___ site
- ___ object

Ownership
- ___ public
- ___ private
- ___ both

Public Acquisition
- ___ in process
- ___ being considered

Status
- ___ occupied
- ___ unoccupied
- ___ work in progress

Accessible
- ___ yes: restricted
- ___ yes: unrestricted
- ___ no

Present Use
- ___ agriculture
- ___ commercial
- ___ educational
- ___ entertainment
- ___ government
- ___ industrial
- ___ military
- ___ museum
- ___ park
- ___ private residence
- ___ religious
- ___ scientific
- ___ transportation
- ___ other:

4. Owner of Property

name

street & number

city, town ___ vicinity of state

5. Location of Legal Description

courthouse, registry of deeds, etc.

street & number

city, town state

6. Representation in Existing Surveys

title has this property been determined eligible? ___ yes ___ no

date ___ federal ___ state ___ county ___ local

depository for survey records

city, town state

7. Description

Condition
___ excellent
___ good
___ fair

___ deteriorated
___ ruins
___ unexposed

Check one
___ unaltered
___ altered

Check one
___ original site
___ moved date ________

Describe the present and original (if known) physical appearance

8. Significance

Period
___ prehistoric
___ 1400–1499
___ 1500–1599
___ 1600–1699
___ 1700–1799
___ 1800–1899
___ 1900–

Areas of Significance—Check and justify below
___ archeology-prehistoric
___ archeology-historic
___ agriculture
___ architecture
___ art
___ commerce
___ communications

___ community planning
___ conservation
___ economics
___ education
___ engineering
___ exploration settlement
___ industry
___ invention

___ landscape architecture
___ law
___ literature
___ military
___ music
___ philosophy
___ politics government

___ religion
___ science
___ sculpture
___ social/humanitarian
___ theater
___ transportation
___ other (specify)

Specific dates ________ **Builder Architect** ________

Statement of Significance (in one paragraph)

9. Major Bibliographical References

10. Geographical Data

Acreage of nominated property ______________

Quadrangle name ______________ Quadrangle scale __________

UTM References

	Zone	Easting	Northing		Zone	Easting	Northing
A				B			
C				D			
E				F			
G				H			

Verbal boundary description and justification

List all states and counties for properties overlapping state or county boundaries

state ________ code ____ county ________ code ____

state ________ code ____ county ________ code ____

11. Form Prepared By

name/title ______________

organization ______________ date ________

street & number ______________ telephone ________

city or town ______________ state ________

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89–665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

State Historic Preservation Officer signature ______________

title ______________ date ________

For NPS use only

I hereby certify that this property is included in the National Register

______________ date ________

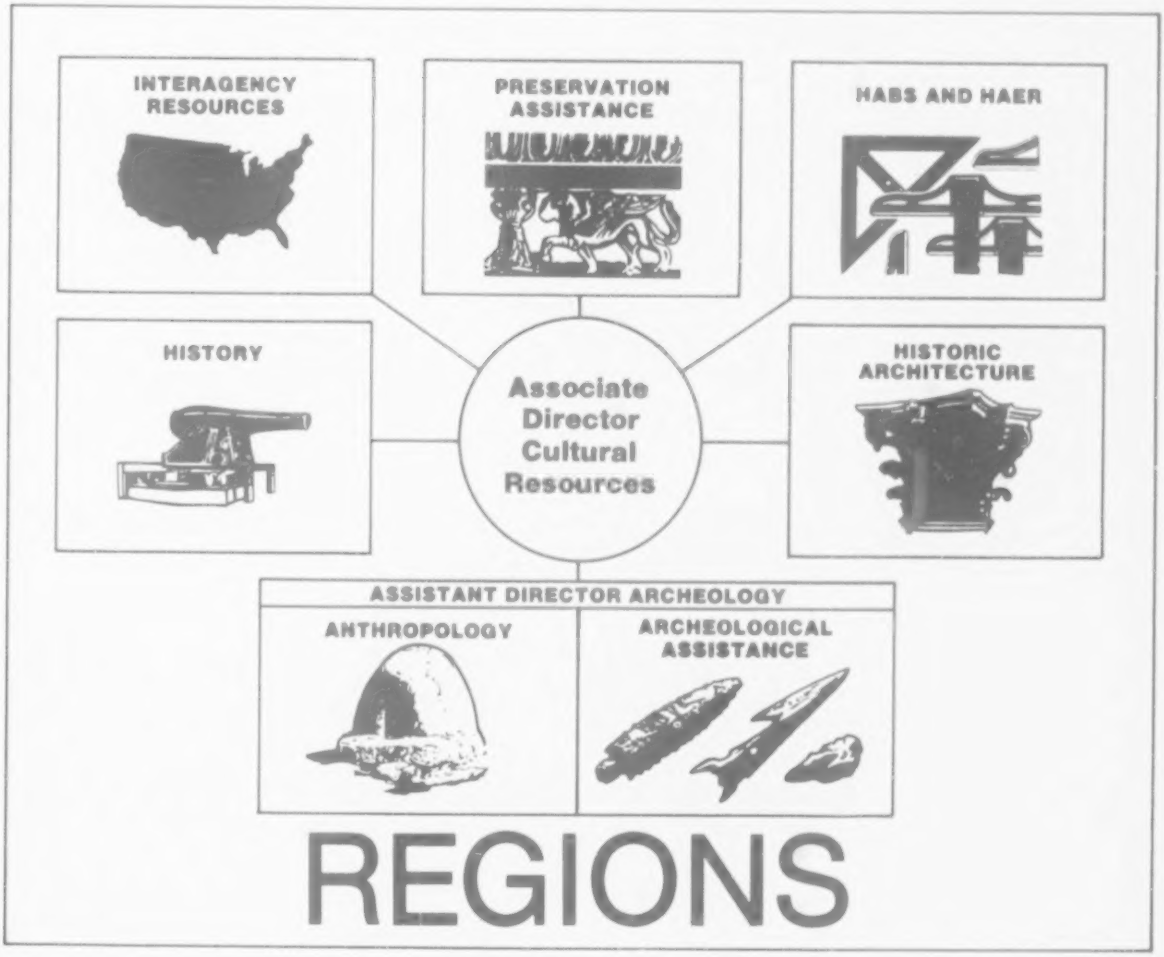
Keeper of the National Register

Attest: ______________ date ________

Chief of Registration

Appendix F

U.S. National Park Service Cultural Programs[1]


INTERAGENCY RESOURCES
PRESERVATION ASSISTANCE
HABS AND HAER
HISTORY
Associate Director Cultural Resources
HISTORIC ARCHITECTURE
ASSISTANT DIRECTOR ARCHEOLOGY
ANTHROPOLOGY
ARCHEOLOGICAL ASSISTANCE
REGIONS

Management of Submerged Cultural Resources in the National Park System

The Submerged Cultural Resources Unit was established by the Service in 1979 at the Southwest Regional office with the servicewide mission to provide technical assistance and project supervision to park managers in meeting their needs for the conservation, management, protection, and visitor appreciation of submerged cultural resources in units of the National Park System. In addition, the unit provides professional assistance to the Chief Anthropologist, Washington Area Service Office (WASO) in developing policy, guidelines and program standards.

The unit staff consists of a chief, two cultural resources specialists, one diving technician, and a secretary. The chief and operations staff are certified scuba divers. All project work is identified by park management and requested through the region needing the services of the unit. Staff salaries come from Cultural Resources Preservation Program, but all costs of project work are paid by the requesting park or its region. With management approval, reimbursable project work for other agencies or institutions can be arranged with the provision that park work takes priority. The unit is under the line supervision of the Regional Director, Southwest Region who should be contacted concerning services of the unit. The Chief Anthropologist, WASO, provides program oversight and works closely with the Regional Director concerning the servicewide aspects of the program.

---

[1] OTA requested the National Park Service to provide additional information for the report. The Office of Cultural Programs kindly provided these summaries of some of their programs in cultural resource management.

The project work of the unit is multidisciplinary, needing the involvement of historians, curators, historical architects, park rangers and technicians, and park maintenance staff. The unit's staff are archaeologists. As part of their work in the parks, the unit not only identifies, evaluates, and provides national register nominations of submerged park cultural resources but also trains park rangers in the techniques of submerged cultural resources surveys, visitor safety while wreck-diving, hazard assessment, wreck interpretation, and similar park-based, visitor-oriented activities. When the unit leaves a park after a project, the park manager has a staff trained to carry out the responsibilities for the management, preservation, and visitor protection and visitor use of submerged cultural resources.

Project work has included underwater surveys at Isle Royale National Park, Biscayne National Park, Point Reyes National Seashore, Assateague Island National Seashore, War in the Pacific National Historical Park, and the U.S.S. *Arizona* Memorial.

In addition to the above activities and projects of the Submerged Cultural Resources Unit, the National Park Service, under Interagency Agreement IA-0773-4-8004, provides professional assistance to the Marine Sanctuary Program of the National Oceanic and Atmospheric Administration concerning the conservation and management of submerged cultural resources in marine sanctuaries.

National Park Service Activities in Remote Sensing

The National Park Service (NPS) utilizes a wide range of remote sensing methods and techniques to identify, record, and evaluate cultural resources. Remote sensing technology is a valuable tool used by archaeologists, historical architects, and other NPS specialists to obtain information about the location; nature; and characteristics of sites, buildings, structures, and objects, and generally in a nondestructive manner. However, the National Park Service does not have a formal program in remote sensing, per se. Instead, the methods and techniques of remote sensing are applied as needed to obtain information for cultural resources studies, management, and planning. Remote sensing applications include the use of magnetometers, radar, metal detectors, and resistivity equipment, for example, to define subsurface terrestrial anomalies; multispectral aerial photography to define vegetational, landform, and soil patterns, and to develop maps of terrain and cultural sites and features; assorted equipment such as side-scan sonar, magnetometers, and sub-bottom profilers for underwater investigations; and hand-held still photograph and video cameras for recording archaeological sites, buildings, objects, and other cultural phenomena. Remote sensing technology is regularly employed by NPS personnel or specialists under contract in many of the 10 National Park Service regions, including staff at our several archaeological centers, and the Submerged Cultural Resources Unit.

National Park Service Activities in Landscape Preservation

The National Park Service has taken the lead in coordinating a program for landscape preservation and has initiated a number of projects. We have worked with Congressman John Sieberling and his staff for changes in the Olmsted bill that the Service can support; the bill awaits passage in the Senate.

NPS is also working with the American Society of Landscape Architects (ASLA), the National Association of Olmsted Parks (NAOP), and others in their efforts to inventory and nominate landscapes to the National Register. Inventory forms, prepared jointly by NPS, NAOP, ASLA, and a number of State Historical Preservation Offices (SHPOs), have been distributed to all Federal Preservation Officers and SHPOs. A "How-To" bulletin on nominating designed landscapes to the National Register was prepared by Timothy Keller, ASLA, and is in the final stages of completion.

Next year, we expect to prepare a "How-To" bulletin on nominating vernacular landscapes to the National Register. This will be based on the handbook *Cultural Landscapes—Rural Historic Districts in the National Park System*. A model nomination to the National Register is being prepared by Tom Kane, FASLA, with funding from the National Endowment for the Arts. Shary Berg, site manager of Olmsted National Historic Site and the NAOP are preparing a model nomination form for designating landscapes as National Historic Landmarks.

Activity within the Washington Office of the National Park Service includes work on a subset database on landscapes and reports about landscapes in the National Park system prepared by the Park Historic Architecture Division. The Historic American Buildings Survey is developing methods for recording landscapes. Last year, they recorded the designed landscape at Meridian Hill Park (Washington, DC), and this year will be recording the vernacular landscape and historic scene at Antietam National Battlefield.

Cultural Landscape definitions and guidelines for preparing Cultural Landscapes Reports are now published in NPS-28, Guideline for Cultural Resource Management. Revisions of the NPS Management Policies, now in draft, contain new sections on landscape preservation, including identification, evaluation, protection, and treatment.

The National Park Service has sponsored and participated in a number of seminars, workshops, and training sessions, including the NCSHPO annual meeting in March 1985; Office of Technology Assessment meetings in Februrary 1985 and April 1986; the NPS Landscape Preservation Field School held in March 1985 and April 1986; and the NPS Science Conference in July 1986 (with major involvement with natural scientists on vegetation management issues).

The National Park Service also has several projects planned for the future, including the development of definitions of "Historical Landscape Architect" and the preparation of "Tech Notes" on landscape preservation.

NPS invites discussion on what impact landscape preservation policy has on land use policy and agricultural economics, and on what NPS's role in rural preservation should be beyond listing rural historic districts on the National Register. For further information on landscape preservation, contact Hugh Miller, Chief, Park Historic Architecture Division.

NPS Tasks for Landscape Preservation Programs

Task 1: Develop Bibliography of Past NPS Reports on Historic Landscapes. This has been done and is ongoing.

Task 2: Develop a Model Cultural Landscape Report. Several reports are now in progress.

Task 3: Organize and Conduct Historic Landscapes Workshop in Conjunction With the NCSHPO Meeting. This took place. NPS is willing to do more.

Task 4: Assure that The Landscapes Inventory Is Compatible With the List of Classified Structures. This has been done and NPS is now working on the second generation of information, coordinating with the National Register.

Task 5: Develop Several Model National Register Nominations for Historic Landscapes. This is in progress.

Task 6: Develop "How To" Technical Bulletin Showing How To Nominate Historic Landscapes to the National Register. This is complete and should be distributed soon.

Task 7: Research Past NPS Guidance for Historic Landscape Terminology; Make Recommendations Concerning Development of a Glossary. The research is done and the glossary is in NPS-28.

Task 8: Develop a Model National Historic Landmark Nomination on an Historic Landscape. This has begun by volunteers.

Task 9: Develop a Technical Bulletin Showing How To Document Historic Landscapes to HABS/HAER Standards. Two wetlands projects are being done.

Task 10: Develop a Definition of "Historical Landscape Architect" Comparable to the Other Discipline Standards Used in Cultural Resources. NPS has begun this definition.

Task 11: Develop Several Tech Notes on Historic Landscape Subjects. NPS has not yet started this task.

Task 12: Encourage States and Federal Agencies To Inventory Historic Landscapes and Include Them in the State and Federal Inventories of Historic Properties. NPS has done this and will continue to encourage such inventories.

AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS DESIGNED HISTORIC LANDSCAPES NATIONAL LANDSCAPE SURVEY FORM 1985

Control Number______________

1. LOCATION Historic______________________________

Common______________________________

2. LOCATION USGS Quadrangle____________ Acreage____________

City, Town______________________ State______________________

Zip Code_______ County___________ Congressional District__________

UTM Coordinates ______________________________

3. OWNER OF PROPERTY (If group or government agency, give contact.)

Name____________________________ Phone______________

Street Address______________________________

City/Town______________________State___________Zip Code________

Pertinent Information______________________________

4. DESIGNED LANDSCAPE TYPE Check category(s) for landscape surveyed.

__Residence __Garden __Estate __Public Building __Institution

__Monument __Botanical Garden __Square or Commons __Streetcape

__Park __Parkway __Park System __City/Town Plan

__Fort __Cemetery __Pond/Canal/Water Feature

5. LANDSCAPE STATUS Please describe as required below.

Ownership: __Public __Private________________ Other, please note

Public Acquisition: __Considered __In Progress __Not Considered

Access: __Unrestricted __Restricted __No Access

Status: __Safe __Endangered __Preservation Action Needed

Preservation action undertaken, describe____________________

____

Further Information:

6. LANDSCAPE ADDRESS AND BOUNDARY INFORMATION

Specific Location (Street, road, features comprising the boundary__

____

Location of legal description. Give contact person, if known.

Courthouse/Registry of deeds______________________________

Street Address______________________ City/Town__________

State____________ Zip Code____________ Phone__________

7. REPRESENTATION IN OTHER SURVEYS Yes or No, Please explain.

__National Register __National Landmark __State Designation

__Local Designation __Other______________________________

Title of Survey and Depository of Survey Records______________

____

8. HISTORIC INFORMATION Check and complete wherever possible.

__Original landscape architect name(s)______________________

__Alteration/addition landscape arch. Names(s)______________

__Original gardner name(s)__________________________________

__Builder/engineer name(s)__________________________________

__Client name(s)____

Date(s) of construction_____________________________________

BRIEF CHRONOLOGY Give pertinent facts about construction, subsequent changes, events, notable occurences:

9. **DESCRIPTION:** Begin with overall description, then note specifics.

Condition
___Excellent
___Good
___Fair
___Deteriorated
___Severely deteriorated

Changes
___Unaltered
___Altered
___Added to
___Loss, removal
___Encroached upon

DESCRIBE EXISTING CONDITIONS Emphasize landscape features, attach plan at 1" = 20' or 1" = 100'. Include a minimum of two photographs of significant views and features with location and direction of view noted on plan:

10. **INTEGRITY** Do these categories exist as in the historic landscape?

__Original design
__Spatial relationships
__Architectural features

__Original property boundary
__Topography/Grading
___Site furnishings

__Design intent
__Vegetation
__Circulation systems

STATEMENT OF INTEGRITY Describe the degree to which the overall landscape and its significant features are present today. Explain categories of integrity noted above and any others that apply:

11. **SIGNIFICANCE** Note reasons landscape is historically important.

__Historic association with person, group, event
__Historic signif. in landscape design
__Historic signif in culture
__Work of recognized master
__Important artistic statement
__Example of fine craftsmanship
__Use of unique materials
__Other verifiable quality________________________________

__Unique regional expression
__Important landmark
__Example of particular style
__Example of particular type
__Example of particular time
__Example of time sequence

STATEMENT OF SIGNIFICANCE Explain categories of significance noted above:

12. **SOURCES FOR INFORMATION:** Note sources used in survey with an *.
__Local repositories (name, address, type of material)____________
____
__Non-local sources of documents (same as above)__________________
____
Bibliography of major published sources:

13. **FORM PREPARATION** Date__________________
Name(s)_____________________________________Phone__________________
Street address____
City/town_______________________State_____________Zip code_______
INCLUDE PHOTOGRAPHS, PLANS, AND MAPS FOR FULL INFORMATION. FOR ADDITIONAL COMMENTS ADD SEPARATE PAGE, USE CATEGORY NUMBERS AS KEY.

Appendix G

Advisory Council on Historic Preservation

Established by the National Historic Preservation Act, this independent agency functions to improve the effectiveness and coordination of public and private efforts in historic preservation. In the realm of Federal activities it advises on policy, recommends guidelines, and reviews and comments on Federal undertakings which have an impact on significant properties. The Advisory Council consists of 19 members including other agency heads, historic preservation experts, a governor, a mayor, and individuals from the general public, and has staff working in offices for Policy and Program Development and for Cultural Resource Preservation. The Council consults with agencies to help them ensure the goals of historic preservation in their activities, and advises the President and Congress on preservation matters in annual reports and in special reports and studies.

One of the most important functions of the agency is mediating between any Federal agency planning an action which threatens a significant property and a local representative concerned with the potential loss of the property. Under the terms of Section 106 of the National Historic Preservation Act, the Council seeks to negotiate a memorandum of agreement in such cases, setting forth what will be done to reduce or avoid any adverse effects the undertaking will have. The consulting parties are at minimum the Federal agency planning an action, the Council, and the appropriate State Historic Preservation Officer. Current standards and regulations, however, make the mediating function available only when the property is included in or eligible for the National Register of Historic Places. No clear mechanism exists for cases where Federal actions have an impact on intangible cultural resources that are not somehow linked to historic properties.

SOURCE: *Cultural Conservation: The Protection of Cultural Heritage in the United States* (Washington, DC: Library of Congress, 1983).

Appendix H

National Trust for Historic Preservation

While constituted as an independent trust and not a Federal agency, the National Trust for Historic Preservation plays an important role on behalf of the government. It was chartered in 1949 to advance the policies of the Historic Sites Act and enhance public participation in historic preservation. Originally the Trust aimed to serve as an agent for receiving historic properties and other gifts to save properties from decay or destruction. Functioning as a small organization, free of bureaucratic regulation, it hoped to supplement Federal efforts. Over the years, the Trust discovered that this strategy did not match the magnitude of the national need for historic preservation, and it came to emphasize public education to stimulate local action in recognizing, maintaining, and protecting properties.

Since the passage of the National Historic Preservation Act, the Trust has received Federal funds to further its work. It has approached a broadened concept of preservation in some of its recent projects, working with community groups to define important cultural items according to local values and to include the maintenance of traditional skills.

SOURCE: *Cultural Conservation: The Protection of Cultural Heritage in the United States* (Washington, DC: Library of Congress, 1983).

Appendix I

National Building Museum

[Section 306] from the National Historic Preservation Act

(a) In order to provide a national center to commemorate and encourage the building arts and to preserve and maintain a nationally significant building which exemplifies the great achievements of the building arts in the United States, the Secretary [of the Interior] and the Administrator of the General Services Administration are authorized and directed to enter into a cooperative agreement with the Committee for a National Museum of the Building Arts, Incorporated, a nonprofit corporation organized and existing under the laws of the District of Columbia, or its successor, for the operation of a National Museum for the Building Arts in the Federal Building located in the block bounded by Fourth Street, Fifth Street, F Street, and G Street, Northwest in Washington, District of Columbia. Such museum shall—
  (1) collect and disseminate information concerning the building arts, including the establishment of a national reference center for current and historic documents, publications, and research relating to the building arts;
  (2) foster educational programs relating to the history, practice and contribution to society of the building arts, including promotion of imaginative educational approaches to enhance understanding and appreciation of all facets of the building arts;
  (3) publicly display temporary and permanent exhibits illustrating, interpreting and demonstrating the building arts;
  (4) sponsor or conduct research and study into the history of the building arts and their role in shaping our civilization; and
  (5) encourage contributions to the building arts;

(b) The cooperative agreement referred to in subsection (a) shall include provisions which—
  (1) make the site available to the Committee referred to in subsection (a) without charge;
  (2) provide, subject to available appropriations, such maintenance, security, information, janitorial and other services as may be necessary to assure the preservation and operation of the site;
  (3) prescribe reasonable terms and conditions by which the Committee can fulfill its responsibilities under this Act.

(c) The Secretary is authorized and directed to provide matching grants-in-aid to the Committee referred to in subsection (a) for its programs related to historic preservation. The Committee shall match such grants-in-aid in a manner and with such funds and services as shall be satisfactory to the Secretary, except that no more than $500,000 may be provided to the Committee in any one fiscal year.

(d) The renovation of the site shall be carried out by the Administrator with the advice of the Secretary. Such renovation shall, as far as practicable—
  (1) be commenced immediately
  (2) preserve, enhance and restore the distinctive and historically authentic architectural character of the site consistent with the needs of a national museum of the building arts and other compatible use, and
  (3) retain the availability of the central court of the building, or portions thereof, for appropriate public activities;

(e) The Committee shall submit an annual report to the Secretary and the Administrator concerning its activities under this section and shall provide the Secretary and the Administrator with other such information as the Secretary may, from time to time, deem necessary or advisable.

(f) For purposes of this section, the term "building arts" includes, but shall not be limited to, all practical and scholarly aspects of prehistoric, historic and contemporary architecture, archaeology, construction, building technology and skills, landscape architecture, preservation, conservation, building and construction, engineering, urban and community design and renewal, city and regional planning, and related professions, skills, trades and crafts.

SOURCE: National Historic Preservation Act.

Index

2

Index

Abandoned Shipwreck Act of 1985, 6, 15, 145
Acid environment
  monitoring, 91
  as threat to cultural resources, 85
Acid rain, 85
Admiralty law, 145
Adobe
  conservation of, 96-97
  stabilizing, 92-93
Adopt-a-site, 103
Advisory Council on Historic Preservation, 10-11, 133, 138, 139*n*, 157
Aerial photography, 17, 38, 44-45
  effective use of, research needed on, 47-48
  historical use of, for monitoring site condition through time, 48
Afro-American Communities Project, 108
Alarm systems, in security efforts, 104
Alaska Native Claims Settlement Act, 6
Alcatraz, 96
Alexandria Urban Archaeology Program, Alexandria, VA, 122
Alvin, 59
American Folklife Center, 123
American Folklife Preservation Act of 1976, 6
American Indian Religious Freedom Act of 1978, 6, 147
American Society of Landscape Architects, Historic Preservation Committee, 14, 147
American Society of Photogrammetry and Remote Sensing, 54
Analysis phase, of preservation process, 43
  technologies for, 18, 21, 59-70
Anasazi sites, 83, 86, 92, 92*n*, 101, 143*n*
Antiquities Act of 1906, 5*n*, 6, 29
Arboretums, 23
Archaeoastronomy, 37*n*
Archaeological and Historical Preservation Act of 1974, 6, 29
Archaeological research, 43
Archaeological resources, State surveys of, 148
Archaeological Resources Protection Act of 1979, 6, 15, 29, 126, 140
  implementation, strengthening, 142-143
Archaeological site(s). *See also* Excavation(s)
  avoidance of, 93
  burial, 93
    as protective measure, 101
  data collection at, 71
  definition of, 30*n*
  inspection, 60
  remote sensing applied to, 44, 47
  sampling and evaluation for excavation, 60
  stabilizing, technologies for, 91
  technologies for preserving, OTA workshop on, 6, 30-31
  types, 30-31
Archaeology. *See also* Underwater archaeology
  avocational interest in, support for, 143
  computer technology for, 137*n*
  conservation, protection, and maintenance practices, 92-93
  data recording, improving, 71
  definition, 30
  historic, 30
  historic aerial photography used in, 48
  issues in, 70-72
  prehistoric, 30
  and preservation of historic structures and landscapes, 8
    issues, 35
  sample collection, improving, 71
  training in advanced technologies for, 151
Archaeomagnetic dating, 18, 21, 31*n*, 59, 67, 68
Architectural plans, preservation of, 117
Architectural record system, computerized, 118
Architecture
  and archaeology, 35
  and structural conservation, graduate education in, 151
Archival phase, of preservation process
  technologies, 18
Archival research, 16, 43-44
  technologies for, 107-109
Archives, for preservation, development, Federal Government's role in, 140
Argo, 59
Arson, 23
Artifacts
  permanent affixation of, 102
  preservation of, 89
  stolen, Federal policy for, 140
Association for Preservation Technology, 152
Association of Universities for Research in Astronomy, 137
Atlantic, 58
Awards program, in preservation, 142

Bar codes, for characterizing artifacts, 71
Barriers, in site protection, 101
Bentonite Slurry Trench method, 99
BIBSCAPE, 115
BIODEX Southwest, 108
BIOFILE Southwest, 108
Bird control technologies, 11
Boston University, Center for Remote Sensing, 54*n*
Botanical technology, 100
Braille, 125
Brick, conservation of, 96-97
Brooklyn Bridge, 8
Building Inventory Inspection Program, 151
Building materials
  education about, 151
  historic, knowledge gaps about, 72-73
  physical analysis of, 73
  substitute, in restoration, 99
Building practices, as threat to structures, 88
Buildings
  historic

    misapplication and nonapplication of technologies to, 95-96
    and modern code requirements, 99
  interpretive presentations of, 130
  modern, misapplication and nonapplication of technologies to, 96
Bureau of Land Management, 101-102
Business, contributions to historic preservation, 153

CADD. *See* Computer-aided design/drafting
Cahokia Mounds State Historic Site, IL, 126
Carbon-14 dating. *See* Radiocarbon dating
Carson House, Eureka, CA, 24
Catastrophic loss, protection from, 23
Central Idaho Wilderness Act of 1980, 6
Certified Local Governments, 11, 76, 133-134
Chaco Canyon National Historical Park, NM, 60, 61, 92
Chemical analysis, in discovery, 62-63
Clara Barton House, Glen Echo, MD, 130
Close-range inspection, 18
Code of Federal Regulations, references to prehistoric and historic preservation, 6
Coffer dams, 70
Colonial Williamsburg, VA, 61
Columbia University School of Architecture, Center for Preservation Research, 151
Community awareness, in historic preservation, 125-126
Computer-aided design/drafting, 90-91
Computer image analysis, in photogrammetry, 53-54
Computers
  adaptation of known technologies to, 79
  application to preservation information needs, impediments to, 115
  in archaeology, 137*n*
  expert systems, 110-111
  in Geographic Information Systems, 63-67
  in identification and survey, 44
  in management of restoration and rehabilitation, 90-91
  networks, 110
  for preservation information, 110-111
  in public education, 123
  role in prehistoric and historic preservation, 39
Concrete, durable, 111*n*. *See also* Reinforced concrete
Conservation phase, of preservation process, 39
  technologies for, 21-23
  traditional technologies in, 37
Construction, as threat to cultural resources, 84
Construction techniques, and preservation problems, 22
Convention on Cultural Property Implementation Act, 6, 16, 86, 141
Cooperative Preservation of Architectural Records, 113
COPAR. *See* Cooperative Preservation of Architectural Records Costs, 154-158
  and economic values, 156-157
  and maintenance, 156
  reducing, 157-158
  of remote sensing technologies, 49
Craftspeople, training of, 153
CRBIB. *See* Cultural Resources Management Bibliography
Crow Canyon Center for Southwestern Archaeology, Cortez, CO, 121-122
Cultural heritage, U.S., preservation of, economic benefits, 9
Cultural Resource Assistance Information Network, 152
Cultural resources
  deliberate destruction, protection from, 101-104
  Federal agencies' inventory of preservation needs and implementation plans, proposal for, 139
  Federal management of, 13-14, 138-139
    improving, 13-14
  human threats to, 84-87
  illicit trade in, Federal policy for, 140-142
  inventory of, 101
  loss of, 83
  management, 72
    foreign policies on, 138
    inadequacies, as threat to resources, 85
    issues, 34-35
    remote sensing in, 54
  monitoring, 91-92
  natural threats to, 84, 87-88
  prehistoric and historic, independent agency for, proposed, 139
  preservation of, 5, 83
  protection of, Federal policy on, 15-16
  research and management process, 16
Cultural Resources Management Bibliography, 112-113
Cylinder recordings, 117

Databases
  database of, proposed, 111
  design, 152
  development of, 109
    Federal Government's role in, 140
  from individual projects, storage of, 109
  keyword retrieval systems, 108
  national, for historic preservation, 116
  for preservation information, 111-115
    Federal, 111
    non-Federal, 113-114
    State, 113-114
  and research costs, 157
  specialized, centralized database of, 116
  standardized formats, need for, 115-116
  technical, 116
    centralized, 140
Dating techniques, 18, 21, 67-69
Decay counting, 67
  methods, 67*n*
DEEP DRONE, 59
Deep sea diving, 69
Defence, 95
Delorme, Philibert, 62
Dendrochronology, 18, 67, 68
Denver Museum of Natural History, 127*n*

Department of the Interior
  Assistant Secretary for Natural and Cultural Resources, proposed, 13, 139
  in management of cultural resources, 13
Department of Transportation Act of 1966, 6
Discovery phase, of preservation process, 16-20, 43
  technologies for, 43-59
  traditional technologies in, 37
Documentary Relations of Southwest project, 108
Documentation phase, of preservation process, 17-18, 43
  technologies for, 59-70, 60
  traditional technologies in, 37
Document copying, 117
Document preservation, 117

Earthen mounds, 88
Earthquake zones
  preservation challenges in, 98-99
  protecting structures in, 23
Earth sciences, in preservation and management of cultural resources, 68-69
Earthworks, 48, 51
  prehistoric, 33
EAVE-EAST, 70*n*
Economic Recovery Tax Act of 1981, 157
Education. *See also* Public education
  Federal programs for, 142
  of preservationists, 35
  in site monitoring, 91
Eisenhower National Historical Site, 85
Electromagnetic spectrum, 46
Electronic media, in public education, 123-124
Electronic monitoring, in protection of cultural resources, 103-104
Electronic position finder, 44, 57
Embodied energy, 157
Engineering, in providing technologies for preservation, 44
Environmental monitoring, 99
Erosion, 39, 84
  aerial photography used to study, 48
  reducing, technologies for, 91
  streambank, mechanisms, 88
  as threat to cultural resources, 87-88
Evaluation phase, of preservation process, technologies for, 20
Excavation(s), 20
  as last resort, 70-71
  numbers of, 31*n*
  remote sensing of sites for, 47
  technologies for, 60
  underwater, technologies for, 70
Executive Order 11593, 6
Exfoliating forces, 96
Exfoliation, on marble, 73
Expert systems, 110-111

Federal Center for Preservation Technology, 12, 13, 139
  recommendation for, 38-39, 135-137
Federal cultural programs, management agency, proposed, 139
Federal Government, role in prehistoric and historic preservation, 133
Federal Land Policy and Management Act of 1976, 5*n*
Federal preservation budget, 134-135
Federal preservation policy, 10-16, 39, 134-148
  and collection of cost/benefit statistics, 156
  improvements to, 139
  lack of agency coordination, 22
Fencing, in site protection, 101-102
Festivals, historic, 126
Fieldwork records, 115
Finding aids, development of, 109
Findley Homestead, Dallas County, IA, 79
Fission track dating, 67
Florida State Conservation Laboratory, 149
Frederick Law Olmsted Historic Site, Brookline, MA, 123
Funding
  Federal, 149
  of historic preservation, 134

Gamma-ray inspection, 21, 44
Gardens, 23
GEOFILE Southwest, 108
Geographic Information Systems, 18, 19, 47, 77
  computerized, 63-67
  regional centers, 66-67
Geographical Resources Analysis Support System, 64
Geomorphology, in dating techniques, 68-69
Georadar, 17
Georgia Institute of Technology, Center for Architectural Conservation, 151-153
Getty Museum, computerized database, 114
GIS. *See* Geographic Information Systems
GRASS. *See* Geographical Resources Analysis Support System
Groundwater levels, 99
Gulf Islands National Seashore, 74
Gunston Hall, 61, 62

HABS. *See* Historic American Buildings Survey
HAER. *See* Historic American Engineering Record
Handicapped access, to cultural resources, 124-125
High-tech solutions, 36
Historical research, 43
Historic American Buildings Survey, 113, 138, 144, 149
Historic American Engineering Record, 113, 138
Historic American Merchant Marine Survey, 144
Historic preservation. *See also* Prehistoric and historic preservation
  avocational interest in, support for, 143
  developing additional support for, 157-158
  improving Federal agencies' coordination and information-sharing, proposal for, 139-140
  integration into university programs, 152
  interdisciplinary approaches, 7
  legislation, 6
  public support for, in U.S., 7
  standards and guidelines for, 6
Historic Preservation Fund, 133, 149

Historic Sites Act of 1935, 6, 29
Horticultural technology, 100
House Committee on Interior and Insular Affairs, Subcommittee on Public Lands, 5, 29

ICCROM. *See* International Centre for the Study of the Preservation and Restoration of Cultural Property
ICOMOS. *See* International Council on Monuments and Sites
Identification, 43. *See also* Discovery phase, of preservation
  process
  technologies for, 44
IMACS. *See* Intermountain Antiquities Computer System
Imaging radar, 17, 19
Incinerator Site, Dayton, OH, 127
Industry, contributions to historic preservation, 153
Informants, in protection of cultural resources, 103
Information. *See also* Preservation information
  about new technologies, problems obtaining, 35
  flow of, 23-24
  in management of cultural resources, 87
  noncomputerized, maintaining, 118
  written and graphic, for public education, 122
Information storage and retrieval, 23, 39
Information systems, 18
  automated, 19
Infrared inspection, 17, 20, 38, 44, 61-62
Infrared moisture detection, 62
Inspection, of archaeological site(s), 60-62
Intermountain Antiquities Computer System, 113
Internal Revenue Service, 10, 135
International Centre for the Study of the Preservation and Restoration of Cultural Property, 37, 114
International Council on Monuments and Sites, 9, 37
Interpretation, accessible, 124-125
Interpreters, in public education programs, 122-123
Interpretive labels, 122
Interpretive signs, 122
  use of, 102
Interpretive structures, 124
Interviewing. *See* Oral histories
Intrusion detectors, 103
Ion counting, 67
Iron, physical analysis, technologies for, 66
Isle Royale National Park, Lake Superior, Michigan, 15

Jason, Jr., 59

Kings Mountain National Military Park, SC, 124
Koster site, 59

Landsat satellite, 45, 47*n*
Landscape architecture
  and archaeology, 35
  preservation of documents in, 117
Landscape records, 76
Landscapes
  analysis and evaluation of
    technologies for, 21
    use of GIS for, 66
  application of technologies to, appropriateness of, 77
  conservation and restoration decisions, 99-100
  cultural, 33, 34
    technologies applicable to, 77-78
  databases on, 115
  definitions, 33, 33*n*
  designed, 34
    restoration of, 89
    technologies applicable to, 78
  designing access to, 125
  different sizes of, different technologies applicable to, 77-78
  historic
    categories of, 75
    identifying, 74
    public education about, 127
    value and significance of, educating constituencies about, 74-76
  historic and prehistoric, survey of, 14
  identification of, 147
  issues about, 74-75
  management, 100
  national preservation policy, 146-148
  nomination to National Register of Historic Places, 20
  planned, 34
    technologies for, OTA workshop on, 6, 33-34
  preservation and restoration
    standards for, 148
    university programs for, 152
  remote sensing applied to, 44
  stabilizing, technologies for, 91
  State surveys of, 149
  stresses on, and change, 76-77
  studying
    foreign technologies for, 38
    interdisciplinary nature of, 76
    qualitative techniques, 79
  survey of, 74, 147
  threats to, 84
  types, 33-34
  vernacular, 34*n*
  wilderness, 33-34
Law enforcement, 83, 142-143
  in protecting cultural resources, 23, 103
Library of Congress, 107
  Committee for the Preservation of Architectural Records, 118
  databases, 113
    for historic preservation, 116
  information about landscapes, 115
  Optical Disk Pilot Program, 113, 116*n*
  survey of architecture of South, 117
Lidar, 44
Lifting balloon, 69
Limestone, preservation of, 89*n*
List of Classified Structures, 112-113
Listening devices, in security efforts, 104
Living history, 126
Local governments, historic preservation policy, 148
Looting, 5*n*, 15, 23, 25, 39, 51*n*, 71, 84, 101, 102, 126

  Federal policy for, 140-142
  as threat to cultural resources, 85-87
Louisiana plantation houses, 96
Louisiana's public education strategies for archaeology, 127-129
Low-tech solutions, 11, 16

MACO 35/70 Analytic Stereoplotter (H. Dell Foster), 52*n*, 53
Magnetic detection, 44
Magnetic disks, for archival purposes, 117*n*
Magnetic tapes, for archival purposes, 117*n*
Magnetometer, 17, 44, 57, 60. *See also* Proton magnetometer
  underwater, 17, 58
Magnetometry, 38
  underwater, 19, 69
Maintenance phase, of preservation process, 21, 39
  and costs, 156
  Federal programs for, proposal for, 139
  inadequate, as threat to cultural resources, 85
  information on, keeping records of, 99
  systematic, long-term, 89-90
  technologies for, 21-23
Management of Museum Properties Act of 1955, 6
Marble
  erosion of, 85
  exfoliation of gypsum crust, 73
Maritime preservation, 10, 38
  Federal agencies with major roles in, 144
  information, preservation, 118
  private sector contributions to, 155
  public education about, 123
  technologies for, OTA workshop on, 6, 31-32
Mary Rose preservation project, 38, 94
Masonry. *See also* Reinforced concrete
  conservation, 96-97
  damage to, 73
  physical analysis, technologies for, 64
  unreinforced, preservation challenges, 98-99
  whitewashing, to prevent moisture damage, 96
Masonry buildings, historic, census of, 113, 152
Masonry Research Institute Foundation, 152
Massachusetts Association of Olmsted Parks, 14
Maya carvings, 89*n*
Measured drawings, 38
Measurement phase, of preservation process, technologies for, 20
Merchants Exchange, Independence National Historic Park, Philadelphia, PA, 85
Metal detectors, 17, 51
Metals, conservation of, 97-98
Microcomputer databases, 113
Mimbres sites, 5*n*, 83
Minerals Management Service, 118
Minute Man National Historical Park, Concord, MA, 84
Mission Espada, San Antonio, TX, 53
Moisture
  control, with masonry, 96
  monitoring, 91
  as threat to cultural resources, 88
Monarch, 15
Monitor preservation project, 38, 57, 59, 94, 124, 136, 144*n*, 146
Monk's Mound, 88
Monticello, 33*n*, 100
  dome of, X-ray inspection, 62
Monuments, permanent affixation of, 102
Mortar, stabilizing, 92, 92*n*
MOSS/MAPS, 64
Mount Dardon, 77
Mount Vernon Ladies' Association of the Union, 32
Mule Canyon Ruin, 125
Multispectral scanners, 17, 44
  for aircraft, 45-46
  for spacecraft, 45
  spectrum used by, 46
Museums, in public education, 25, 127

NASA
  Earth Resources Laboratory, Bay St. Louis, Mississippi, 53, 54
  Remote Sensing Applications Program, 136
National Aeronautics and Space Administration. *See* NASA
National Archaeological Database, 111
National Archives and Records Administration, 107-108
  database, for historic preservation, 116
National Association of Corrosion Engineers, 152
National Association of Corrosion Engineers/National Bureau of Standards, computerized database, 114
National Association of Olmsted Parks, 14
National Astronomical Observatories, 12, 137
National Building Museum, 138
National Bureau of Standards, Center for Building Technology, 73, 74, 96, 136
National Center for Preservation Technology, proposed, 12, 137
National Conference of States on Building Codes and Standards, 136
National Endowment for the Arts, 13, 139
National Endowment for the Humanities, 13, 139
National Historic Preservation Act Amendments of 1980, 6
National Historic Preservation Act of 1966, 5, 6, 10-11, 13, 29, 32, 112, 133, 138, 139, 142, 146, 148
National Historic Preservation Act of 1966, Amendments of 1980, 29, 138, 143*n*, 149
National Historic Preservation Trust Act of 1949, 6, 134*n*
National Institute for the Conservation of Cultural Property, Inc., 156
National Institute of Building Sciences, 136
National Institute of Conservation, 152
National Museum of Building Arts, 11
National Oceanic and Atmospheric Administration, 136, 144*n*
  Sanctuary Programs Division, 146
  and underwater archaeology, 145

National Park Service, 107, 140*n*, 156
  Cultural Programs, 133
  database on preservation information, 140
  educational programs, 121, 123, 130
  information on landscapes, 115
  landscape preservation efforts, 147-148
  in landscape survey, 14
  in management of cultural resources, 138
  National Capitol Regional Center for Urban Ecology, 100
  noncomputerized information, maintenance of, 118
  Preservation Assistance Division, 135
  preservation databases, 111-113
  reports on technologies for historic structures, 137*n*
  research on stabilization of structures, 92
  responsibilities for prehistoric and historic preservation, 13
  Submerged Cultural Resources Unit, 124n, 144*n*, 146
  technical publications on protecting historic buildings, 135
National Park Service Organic Act, 6
National Register of Historic Places, 10, 32, 112, 133, 147, 149
  landscapes incorporated into, 20, 74, 76, 148
  National Register Information System, 111, 114
  nominating shipwrecks to, 144
National Science Foundation, Archaeometry Program, 136
National Technical Information Service, 107
National Trust for Historic Preservation, 11, 134, 138, 144-145
  sponsorship of technical education and research, 152-153
National Union Index to Architectural Records, 113
Native Americans, 121, 147
Natural sciences, in providing technologies for preservation, 44
NCSHPO, 116
Neutron/gamma-ray spectroscopy, 18, 20
  of archaeological site(s), 60-61
Newark Earth Works, Newark, OH, 48
New Jersey Memorial, Valley Forge, PA, 98

Obsidian hydration dating, 18. 59, 67
Oceanographic institutions, 155
Ohio, Old House Doctor Clinics, 150
Old House Journal 152
Old Post Office, Washington, DC, 130
Olmsted Act. *See* Olmsted Heritage Landscapes Act of 1985
Olmsted firms, parks designed by, 14, 14*n*
Olmsted Heritage Landscapes Act of 1985, 6, 14, 147
Olmsted properties, 123
Optical character reader, 19*n*, 23, 108
Optical digitizer, 47
Optical disk technology, 18, 20, 23, 108
  for conservation of records, 117
  for preservation information, 109-110
  for public education, 25, 123
  for survey and identification, 54
Optical scanners, for specific preservation needs, 49
Oral histories, 43-44
Orthophotographic techniques, in archaeological data recording, 71
OTA workshops, 30. *See also specific workshop topic*
Outdoor sites, technologies for preserving, OTA workshop on, 6, 33-34
Outer Continental Shelf Lands Act, 6

Paca House and Garden, Annapolis, MD, 77, 78, 84*n*
Parks, 99-100
Patrols, of sites, as protection measure, 103
Petroglyphs, 22*n*, 93, 129
Photogrammetry, 17, 20, 38, 44
  architectural, 53-54
  computer image analysis, 53-54
  for recording and measurement, 20
  stereo, traditional methods, 52
  stereo analytic systems for, 52-53
  terrestrial, 45
  used in discovery, 52-54
Photography, 44. *See also* Aerial photography
  in archaeological data recording, 71
  in discovery, 17
  terrestrial, 44
    used in discovery, 52-54
Photo-theodolite, 52
Physical analysis, in discovery, 62-63
Pictographs, 22*n*
Plants, historic, 23, 78, 100
Point Reyes National Seashore, 56
Polyethylene glycol, 94
Potassium-argon dating, 67
Pothunters, 103, 126
Precision fathometers, 44, 57
Predictive locational modeling, 17, 19, 66
  in protection of cultural resources, 101
  for survey and identification, 54-56
Prehistoric and historic periods, delineation between, 30*n*
Prehistoric and historic preservation
  applying technologies in
    Federal policy on, 11-12
    Federal role in, 135
  contribution to quality of life, 9-10
  representative disciplines participating in, 31
  standards, policy options for, 136-137
  training for, 136
  transfer of technology from other fields to, 9
Preservation information
  central office for collection and dissemination of, proposal for, 140
  sources, 107
  technologies for, 109-111
Preservation issues, 34-38
Preservation process, 16-25
Preservation Tax Incentives Program, 157
Preservation technologies
  application, impediments to, 8-9, 11, 13
  collection and dissemination of information about,

    Federal policy options for, 137
  cost benefits, 156
  definition, 5, 29
  Federal efforts toward application of, proposal for, 140
  foreign, 9
    transfer to U.S., 37-38
  new
    coordination of use of, 36-37
    difficulties of integration, 37
    difficulty in obtaining information about, 35
    professionals problems obtaining information about, 35
  nontechnical constraints on use of, 29-30
  older, difficulties in application of, 37
  sharing of, 74
  standards for, 36
  traditional, continued utility of, 37
Preservation Technology Board, 12
  Federal policy option for creation of, 137-138
Private sector, contribution to historic preservation, 150-154
Professional societies
  contribution to historic preservation, 150
  with interest in prehistoric and historic preservation, 154
Prospect park, 103
Protection, of prehistoric and historic sites, 39
  Federal programs for, proposal for, 139
  public education about, 127
  technologies for, OTA workshop on, 6, 34
Protection laws, State, 150
Proton magnetometer, 50, 51
Provenance, principle of, 108
Public education, 39
  importance to protection of cultural resources, 121, 126-127
  about preservation process, 25
  restoration and conservation techniques in, 127-130
  State and local efforts toward, 150
Public lands
  access to, as threat to cultural resources, 87
  affecting public attitudes toward, 126
  loss of artifacts from, 86
  management, 5, 5*n*
  relic hunters on, 51. *See also* Pothunters
Public Law 59-209. *See* Antiquities Act of 1906
Public Law 74-292. *See* Historic Sites Act of 1935
Public Law 81-408. *See* National Historic Preservation Trust Act of 1949
Public Law 83-31. *See* Submerged Lands Act of 1953
Public Law 83-212. *See* Outer Continental Shelf Lands Act
Public Law 84-69. *See* Management of Museum Properties Act of 1955
Public Law 86-523. *See* Reservoir Salvage Act of 1960
Public Law 89-665. *See* National Historic Preservation Act
Public Law 89-670. *See* Department of Transportation Act of 1966
Public Law 90-190. *See* National Environmental Policy Act of 1969
Public Law 92-203. *See* Alaska Native Claims Settlement Act
Public Law 93-291. *See* Archaeological and Historical Preservation Act of 1974
Public Law 94-201. *See* American Folklife Preservation Act of 1976
Public Law 95-341. *See* American Indian Religious Freedom Act of 1978
Public Law 96-95. *See* Archaeological Resources Protection Act of 1979
Public Law 96-312. *See* Central Idaho Wilderness Act of 1980
Public Law 96-515. *See* National Historic Preservation Act Amendments of 1980
Public Law 97-466. *See* Convention on Cultural Property Implementation Act
Public spaces, 99-100
Pueblo Alto, 60

R.M.S. TITANIC Memorial Act of 1985, 6
Radar, 44. *See also* Shuttle imaging radar
  ground-penetrating, 44, 50-51
  subsurface, for archaeological discovery, 60
  synthetic, spectrum used by, 46
Radiocarbon dating, 18, 21, 59, 67
Ramon trees, 47*n*
Rangers, unarmed, 103
Reconstruction, and public education, 130
Recording phase, of preservation process, technologies for, 20
Records, conservation, technologies for, 116-117
Registration, of antiquities and artifacts, 15-16, 140-142
Reinforced concrete, 22
  as conservation challenge, 96
  physical analysis, technologies for, 65
Remote cameras, in security efforts, 104
Remote sensing, 38, 38*n*, 43
  from aircraft and spacecraft, 44-49
    for underwater survey, 58
  applied to landscapes, 77
  for archaeological discovery, 60
  costs, 49, 156
  data processing, lowering costs of, 49, 49*n*
  definition, 44*n*
  for discovery, 19, 44-54
  geophysical, 45, 49-52
  indirect, 47
  instruments, 45
  matching preservation data needs with, 49
  in monitoring cultural resources, 91
  technologies, 17
  training in, 54
  underwater, 57
  use by looters, 71-72
Remote sensing satellite, 45
Remotely operated vehicles, 17, 19, 20, 44, 69, 69-70
  in underwater survey and identification, 58-59

Requests for Proposals, technological applications in, 135
Research
  documentary, 10
  in preservation, challenges to, 98-99
  on preservation problems, Federal policy options on, 136
  public education about, 122
  steps, 43
Reservoir Salvage Act of 1960, 6
Restoration phase, of preservation process, 39
  technologies for, 21-23
  traditional technologies in, 37
RESTORE, 136, 153
Revenue Act of 1978, 157
Reynolds Tavern, Annapolis, MD, 97
Richmond Battlefield, 51*n*
Rock art, 127
  conservation of, 22-23
  definition, 22*n*
  moisture damage to, 88
  preservation, 93
Ronson Ship, 94
Roplex, 92
ROVs. *See* Remotely operated vehicles

SAGIS, 64
Salem, MA, 77*n*
San Juan, 95
Saturation diving, 69
Scorpio 70
Scuba diving, 56, 69
Security, technologies for, 101-104
Sedimentology, in dating techniques, 68-69
Seismic detection, 44
Serpent Mound, 7, 55
Settlement patterns, 34
Ship restoration, 144
Shipwrecks
  conservation practices, 95
  databases on, 114
  excavations, 70
  Federal policy on, 14-15
  looting, 71-72
  national preservation policy for, 143
Shuttle imaging radar, 45
Side-scan sonar, 17, 19, 44, 57
  use of, 57
Site-landform correlations, 56*n*
Site management, computer technology in, 90
Sleepy Hollow Restorations, 100
Smithsonian Institution, 107
Snow Squall project, 94
Social science techniques
  in dating techniques, 68-69
  in identification and survey, 44
Society for Archaeological Sciences, 154
Soil conductivity meter, 17, 50
Soil resistivity, in archaeological discovery, 60
Soil resistivity meter, 17, 50
Sourdough Roadhouse, 26
Space photography, 17
Spectral bands, for aerial scanning spectrometers, 48-49
SPOT, 45
State governments, historic preservation policy, 148
State Historic Preservation Officer, 10, 133-134, 147
State Historic Preservation Offices, 11, 133-134, 148, 149
  computerized databases, 113-114
  Federal cooperation with, 135
State records, handling, 149
State surveys, 148-149
Statue of Liberty, 97
Steel, physical analysis, technologies for, 66
Stereo analytic plotting systems, 52-53
Stereo photography, in public education about underwater archaeology, 124
Sting operations, for recovery of stolen artifacts, 103
Stone
  conservation of, 96
  exfoliation of, 96*n*
  moisture damage to, 88
Stonehenge, 55
Structural damage, 22
Structures
  archaeological, technologies for preservation of, OTA workshop on, 6
  definition of, 32*n*
  historic
    analysis in context, 74
    areas of significance and activity represented by, 33
    change over time, documenting, 74
    environmental stresses on, 22
    fragile, preservation challenges, 98
    as interdependent system, 21
    intrusion into, 23
    issues about, 72-74
    misapplication and nonapplication of technologies to, 95-96
    monitoring, 91
    national preservation policy, 146
    nondestructive analytical techniques for, 72
    NPS publications on protecting, 135
    preservation of, lack of standards in, 36
    protection against catastrophic loss, 23
    research into history of, and use of technology, 73-74
    restoration, conservation, maintenance, and protection
      need for information on, 116
      practices, 95-99
    State surveys of, 149
    technologies for preserving, OTA workshop on, 6, 32-33
    types, 32
  West German methods of recording, 38
Sub-bottom profilers, 17, 19, 44, 57-58
Submerged Lands Act of 1953, 6, 143
Submerged resources, 32, 38
  identification and survey of, 56-59

inventory of, 14
materials recovered from, conservation of, 21
Sucrose, in conservation of waterlogged artifacts, 94
Sunnyside, 125*n*
Survey, 43. *See also* Discovery phase, of preservation process
technologies for, 44

Take Pride in America program, 142
Tax Act Rehabilitation Certification Program, 135
Tax incentives, 32, 83, 91, 135, 144, 156, 157
for preservation, 10
Tax Reform Act of 1976, 157
Technology. *See* Preservation technologies; *specific technique*
Technology and Conservation, 152
Technology sharing, cooperation between Federal and State
governments in, 149-150
Technology transfer, 37-38, 135
promoting, 153-154
public/private partnerships in, 153-154
Terra cotta, conservation of, 96-97
Texas Antiquities Commission, 114
Thematic Mapper, 45, 47*n*, 52
spectrum used by, 46
Thermal scanning, for discovery of archaeological remains, 49
Thermography, 44
Thermoluminescence dating, 67
Thunderbird Museum and Archaeological Park, Front Royal, VA, 130
Titanic, 59, 136
Tours, in public education, 123
Training
in architectural conservation, 152-153
of preservationists, 35, 150-153
Tree ring dating. *See* Dendrochronology

Ultraviolet inspection, 18, 20, 61-62
Underwater archaeological resources, State surveys of, 148-149
Underwater archaeology, 10, 38
combined conservation and documentation, 95
conservation, maintenance, and protection practices, 93-95
conservation through technology, 95
costs for, 155
databases, 114
dependence on advanced technology, 72
Federal agencies with major roles in, 144
full-scale conservation in, 94-95
information on resources and technology, 118
issues in, 72
legislative initiatives for, 144-145
national preservation policy for, 143-146
postponement of conservation in, 95
practitioners, 31
private sector contributions to, 155
public education about, 123-124
raising visibility of, in Federal Government, 145-146
recording and measurement technology, 20
research design in, 72
survey technologies, 19-20
technologies for, 69-70
OTA workshop on, 6, 31-32
technology transfer in, 153-154
training in advanced technologies for, 151
UNESCO, 37
UNESCO Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property, 16, 86, 141
United Nations Educational, Scientific, and Cultural Organization. *See* UNESCO
Universities, contribution to historic preservation, 150-154
University of Colorado, Center for Earth Observations and Remote Sensing, 54*n*
University of Maryland, Architecture and Engineering Performance Information Center, 114
U.S. Army, building preservation policy, 146
U.S. Army Corps of Engineers, 137*n*
study of erosion, 48
U.S. Navy
research on preservation problems, policy options for, 136
Submarine Development Group, 154
and underwater archaeology, 145, 153-154
U.S. Postal Service, building preservation policy, 146
Utah, southeastern
law enforcement efforts in, 143*n*
loss of cultural resources from, 83, 86*n*, 87

Vandalism, 5*n*, 15, 23, 25, 39, 84, 101, 102, 126
computer technology in managing, 90
Federal policy for, 140-142
as threat to cultural resources, 85-87
Vegetation
managing growth of, 100
patterns, used in survey, 52
propagation of, in protection of sites, 102
Venice, Italy, 61
Video technology, 44
in archaeological data recording, 71
color, 71*n*
for discovery, 17, 19-20
in handicapped access to cultural resources, 125
in public education, 25, 123
for survey and identification, 54
underwater, 123
Visitation
computer technology in managing, 90
as threat to cultural resources, 84
Visitor's centers, 124
Volunteers, in creating community awareness, 126

Wasa preservation project, 38, 94
Waterlogged cultural materials, conservation of, 94-95
Waverly Mansion, 96

White Mesa Institute, College of Eastern Utah, Blanding, UT, 122
Wood
  building practices using, 88
  physical analysis, technologies for, 63
  stabilizing, 92
Woods Hole Oceanographic Institution, Deep Submergence Program, 136

X-ray inspection, 18, 20, 21, 44, 61-62

York Minster, 127-130
Yorktown Archaeological Park, Yorktown, VA, 70

Office of Technology Assessment

The Office of Technology Assessment (OTA) was created in 1972 as an analytical arm of Congress. OTA's basic function is to help legislative policymakers anticipate and plan for the consequences of technological changes and to examine the many ways, expected and unexpected, in which technology affects people's lives. The assessment of technology calls for exploration of the physical, biological, economic, social, and political impacts that can result from applications of scientific knowledge. OTA provides Congress with independent and timely information about the potential effects—both beneficial and harmful—of technological applications.

Requests for studies are made by chairmen of standing committees of the House of Representatives or Senate; by the Technology Assessment Board, the governing body of OTA; or by the Director of OTA in consultation with the Board.

The Technology Assessment Board is composed of six members of the House, six members of the Senate, and the OTA Director, who is a nonvoting member.

OTA has studies under way in nine program areas: energy and materials; industry, technology, and employment; international security and commerce; biological applications; food and renewable resources; health; communication and information technologies; oceans and environment; and science, education, and transportation.

OTA-E-319 SEPTEMBER 1986